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Construction Engineering
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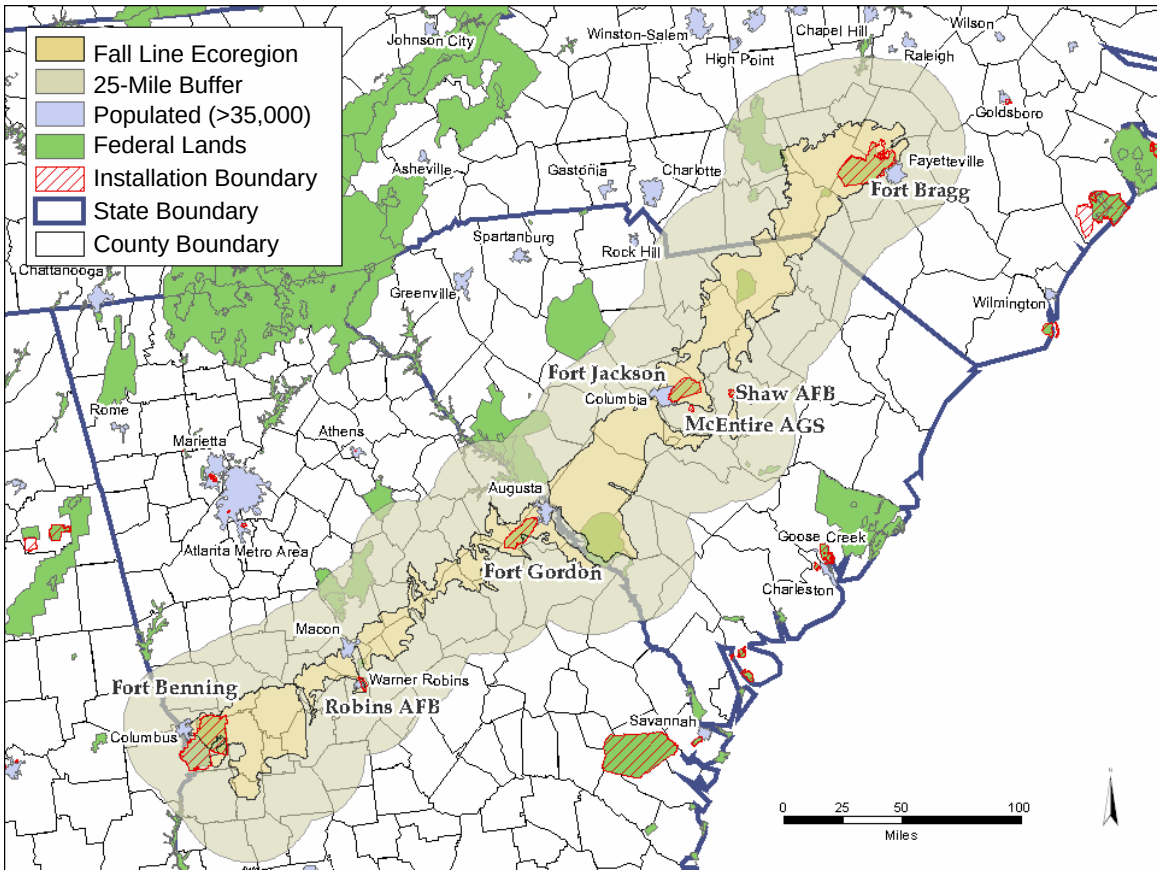
Strategic Sustainability Assessment Pilot Study

Fall Line Region of the Southeast

Elisabeth M. Jenicek, Natalie R.D. Myers,
Brad Boesdorfer, and Donald F. Fournier

November 2006



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Abstract: Strategic Sustainability Assessment (SSA) is a long-term project sponsored by the Army Environmental Policy Institute (AEPI), which seeks to provide a fact-based visualization of trends and issues that allows the Army to project the future in terms of the issues critical to sustainability. SSA will produce a variety of models and research tools that will provide strategic analyses in the form of ongoing, regular studies and reports that focus on specific regions or issues, and that help develop implementation plans and concepts for the Army Strategy for the Environment. This initial stage of research defined and conducted specific analyses of key forces, outcomes, and trends related to the SSA as it applies to Army installations using the 20- to 30-year time horizon. This work used a combination of forecasting and backcasting methods to investigate how installations in the selected focus region can overcome specific encroachment concerns and begin to develop sustainable management plans.

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Preface

This study was conducted for the Army Environmental Policy Institute under Work Units DL01HC, "Strategic Sustainability Regional Pilot Study," and FG79D2, "SSA Strategic Interventions." The technical monitors were Michael Case and William Goran, Director of Special Projects, Construction Engineering Research Laboratory (CERL).

The work was performed by the Energy Branch (CF-E) and the Engineering Processes Branch (CF-N) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Elisabeth M. Jenicek. Thomas J. Hartranft is Chief, CF-E, Donald K. Hicks is Chief, CF-N, and L. Michael Golish is Chief, CF. The associated Technical Directors are Michael Case and William Goran. Part of this work was done by Donald Fournier of the University of Illinois at Urbana-Champaign under contract number DACA88-99-D-002, Delivery Order 0031, and by Natalie R.D. Myers and Brad Boesdorfer of the PERTAN Corporation. Thomas Hartranft is Chief, CEERD-CF-E, Donald K. Hicks is Chief, CEERD-CF-N, and Michael Golish is Chief, CEERD-CF. The Director of CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Richard B. Jenkins, and the Director of ERDC is Dr. James R. Houston.

1 Introduction

Background

The new *Army Strategy for the Environment: Sustain the Mission – Secure the Future* (ASA–I&E 2004) establishes a long-range vision for enabling the Army to meet its mission today and into the future. Sustainability is the foundation of the Strategy and represents a paradigm that focuses the Army's thinking to address both present and future needs while strengthening community partnerships that improve the Army's ability to organize, equip, train, and deploy as part of a joint force. The Strategic Sustainability Assessment (SSA) is a long-term project sponsored by the Army Environmental Policy Institute (AEPI). The Institute seeks to provide a fact-based visualization of trends and issues that allows the Army to see the future in terms of the issues that are critical to sustainability. AEPI intends to use a variety of models and research tools to provide strategic analyses for the Army in its journey to increasing sustainability. The envisioned product is a series of ongoing, regular studies and reports that focus on specific regions or issues that enable the development of implementation plans and concepts for the *Army Strategy for the Environment*. The project has several byproducts, for example, building beneficial partnerships with organizations also working on sustainability, as well as creating opportunities for further dialogue with internal and external stakeholders.

The goals of the SSA project are:

1. To provide Army leadership with an assessment of the state of the Army's sustainable future and to offer recommendations for policy development and new initiatives as the Army works to achieve the goals of the *Army Strategy for the Environment*.
2. To bridge the gap between short-term planning to implement the Strategic Plan and to identify actions needed in the long term to ensure that the Strategy goals are met within the 20- to 30-year timeframe set by the Strategy.
3. To create a forum for ongoing dialogue among Army leadership and other partners working toward sustainability.

Objectives

The objective of the initial stage of research is to define and conduct specific analyses of key forces, outcomes, and trends related to the SSA as it

applies to Army installations using the 20- to 30-year time horizon. The objective of the next stage of research is to select a preliminary study area for specific demonstration projects and to apple trending analyses and modeling concepts as introduced in the SSA framework.

Approach

In the initial stage of research (accomplished in June 2005), researchers:

1. Performed an initial literature survey
2. Conducted scoping meetings to define appropriate methodologies and tools
3. Determined key long term sustainability issues
4. Put this information in a context that informs the implementation of the Army's Strategy for the Environment.

Scope

The initial stage of research reviewed concepts and established methodologies to be used to review environmental issues in a strategic context as they apply to military installations and Army Transformation. This work further investigated how installations in the selected focus region can overcome specific encroachment concerns and begin to develop sustainable management plans. The regional assessment process described in this report relies on a combination of forecasting methods (which summarize expected future events) and backcasting methods (which determine how a desired future can be attained in light of present conditions and possible future scenarios) methods.

Mode of Technology Transfer

This research will produce a series of ongoing, regular reports focusing on specific regions or issues that will be presented at workshops and symposia, and will be made available through the World Wide Web (WWW) at either (public or secure, respectively) URLs:

http://www.cecer.Army.mil

https://websps1.battelle.org/aepi/StrategicSustainabilityIAST/default.aspx

2 Issues Leading to Regional Analysis

Background

As the Army Transformation continues, it must ensure that installations are the right size and place, are of the right quality, have the right safety and security, and execute the right resources. The successful operation of installations requires clean air and water, thousands of kilowatt-hours of electricity, and expansive, undamaged training areas to effectively train troops. At the same time, public use of these limited resources continues to grow—creating substantial environmental challenges termed "encroachment." The problem of encroachment arises because both public and private sectors need land for different activities, and those differing needs compete with one another. The U.S. General Accounting Office's (USGAO's) research (USGAO 2002b) into service readiness shows that training installations are losing capability in terms of the time training ranges are available for use and/or the types of activities that can be conducted on those ranges. Encroachment is occurring for a number of different reasons. Civilian activities (residential and commercial development) are expanding into formerly remote military training areas. Public concerns for habitat preservation and enhancement are increasing. The military is responding to the need for force transformation, and the consequent need to change training requirements.

Army installations must "sustain" their own existence in the context of surrounding civilian communities, the environment, and the Army as a whole. "Unsustainable" installations face a number of risks, including closure. Installations compete with surrounding communities for limited resources such as land or water. Communities that neighbor installations often grow towards the installation's borders. Consequently, if the installation has not actively implemented sustainable practices, its perceived value to the community as an economic good neighbor, or military protector might be outweighed by its value as a source of valuable land (or other resources), or by its perception as an environmental (or noise) polluter. Army installations must also conform to the same environmental regulations as their civilian neighbors across the fence. Noncompliance with environmental regulations leads to monetary fines and can project an image of the installation as an inconsiderate neighbor. In a broad context, instal-

lations must also compete against each other for their very existence as the Army of the future trims real estate.

Still, "sustainability" is not yet a clearly defined concept. Army installations are just now beginning to develop objective indicators of sustainability, and they have no clear path to achieve sustainability. There is a need to define what is meant by a "sustainable Army installation," to identify indicators of sustainability, and to identify ways to achieve sustainability that will enhance military installations' survivability and competitiveness as a platform for accomplishing the Army mission.

Military noise, air pollution, and water pollution can threaten or annoy the public. On the other hand, public civilian activity, from automotive traffic to use of the electromagnetic spectrum, to even a rise in ambient light levels at night, may interfere with military operations. Both circumstances can be termed "encroachment." Additionally, the continuing development of historically open spaces in our country directly damages our landscape, natural resources and agricultural land, and waterways. Government actions such as the Endangered Species Act, the Migratory Bird Treaty Act, the Marine Mammal Protection Act, and other laws were enacted to protect those resources. Some within the military have described enforcement of those laws as "regulatory encroachment." Augmenting these pressures is internal transformation within the Department of Defense (DoD). New weapons (which fire further) and new vehicles (which travel faster) require larger training and testing areas. Moreover, the Army is changing the way it fights and operates to become a more powerful, more flexible, more rapidly deployable, standalone force. Stationing decisions being made today are moving away from division-centric structures to accommodate the return of soldiers from overseas locations by the end of the decade.

Driving Forces

Encroachment is a major driver for sustainability analyses. Installations and communities will both require a new, truly sustainable approach to maintain readiness and fulfill their missions. DoD documentation is already shifting to support sustainability analyses by recognizing that military installations are often the catalyst for actions and developments occurring outside installation boundaries. The DoD acknowledges that today's military installations are struggling with ever-increasing readiness requirements that involve the need to train more soldiers on less land. In addition to time and spatial constraints, installation Commanders face challenging environmental factors and growing encroachment issues that

can seriously restrict, and in some cases shut down, an installation's ability to train its troops.

The recently published *Army Strategy for the Environment: Sustain the Mission – Secure the Future* (U.S. Army 2004) establishes a long-range vision for enabling the Army to meet its mission today and into the future. Sustainability is the foundation of the Strategy and articulates a paradigm that focuses the Army's thinking to address both present and future needs while strengthening community partnerships that improve the Army's ability to organize, equip, train, and deploy as part of a joint force.

The *Army Strategy for the Environment* is consistent with the 2005 Army Campaign Plan in that it emphasizes the fact that environmental and operation sustainability represents a vital component of the Army's mission. The Campaign Plan describes the restructuring plan for the U.S. Army and articulates the Army's overarching strategic goal to remain relevant and ready by providing the Joint Force with essential capabilities to dominate across the full range of military operations:

> The Army will remain relevant to the challenges posed by the global security environment – across the range of military operations from irregular conflict to high intensity conventional warfare – and ready to provide the forces and capabilities required by the Combatant Commanders and the Joint Team (U.S. Army 2005).

In addition to the *Army Strategy for the Environment,* there are several documents supporting the Campaign Plan. Each focuses on thinking strategically to advance Army objectives, reinforces the strategic direction and momentum, highlights progress, and articulates further strategic communications and goals to support achieving the objectives of the Army Campaign Plan. These documents include the *2005 Army Modernization Plan, The Army Game Plan, 2005 Army Modular Force, Army Strategic Planning Guidance, The Army in 2020, The Army Installation Strategic Plan, 2003 Way Ahead,* and *2002 National Security Strategy*.

Specifically, the *2005 Army Modernization Plan* describes the modernization and investment strategies adopted to enhance the effectiveness of the Current Force while pursuing critical capabilities for the Future Force. Along with the *Army Science and Technology Master Plan,* it provides the rationale and justification for the research, development, and acquisition of new and improved capabilities. The *Army Game Plan* focuses on the goals of the *Campaign Plan* over a longer time frame. It emphasizes the

role that leaders must play to "lead change while managing complexity." The *Army in 2020* is a self-described "think piece" broadly outlining changes in doctrine, organization, training, material, leaders and education, personnel, and facilities that senior leaders believe are necessary to transform the Army toward greater relevance and readiness for threats in the 21st century. *The Army Installation Strategic Plan*, a companion to many of these documents, highlights the view that, to enable the force to fulfill its strategic roles and missions, the Army must support soldiers by maintaining high standards for quality of life, and a modern infrastructure. Collectively, today's Army has four overarching interrelated strategies centered on:

1. Providing relevant, ready land power to support the combatant commanders
2. Training and equipping soldiers to serve as warriors and growing adaptive leaders
3. Attaining quality of life and well-being for our people that match the quality of their services
4. Providing infrastructure to enable the force to fulfill its strategic roles and missions.

Installations provide the Army with the essential resources needed to achieve its goals. Thus, Army installations must take up the challenge to support emerging operational and support mission requirements by developing a culture of innovation that increases both agility and productivity for today and the future. This culture requires cooperation to resolve regional environmental, economic, and social issues. The DoD has clearly set a new approach to environmental management, one that is no longer compliance-based either from the "top-down" or "bottom-up," but is instead based on sustainable installations that can ensure long-term readiness by proactively planning to avert potential threats.

Historically, national sustainability efforts have been too broad in scope and rely on overly general encroachment concerns. On the other hand, local efforts are too narrow in scope and tend to ignore integrated transformations. Today's planning must achieve that integration through regional strategic alliances. Until now, sustainability has not often been addressed at the regional level. The need to initiate regional efforts to address the Army's new approach to environmental management, and to military installations and Army transformation is a driving force for the Strategic Sustainability Assessment Program.

3 Sustainability Planning

Serious consideration must be given to defining a more sustainable path for the nation and, in particular, to military installations. Historically, sustainability and encroachment efforts have been addressed generally at the national level or specifically at individual localities such as cities. This is true both within and outside of the DoD. Today the DoD is committed to proactive environmental/sustainability management of all military lands as a joint force, which makes the ability to think and act regionally critical to sustainability. Each military service has expressed the need for better understanding between trends on military lands and regional environmental processes. Efforts undertaken to address these concerns vary across the nation.

Although all sustainability efforts share the concept of living within resource limits, individual sustainability efforts vary considerably. The scale of planning/analysis can vary widely, geographically or politically. For example, outside the DoD, sustainability is often evaluated on global, national, regional, and local levels. Similarly, some programs within the DoD provide the capability to compare military installations in different regions. Some sustainability efforts focus on a single-issues, e.g., on economic and infrastructure development ("sustainable development") or on environmental issues ("environmental sustainability"). Traditional broad definitions of sustainability recognize the relationships between economy, society, and environment. The Army's approach is to strive to meet a triple bottom line of sustainability: mission, environment, and community.

Geographic and Political Scale of Sustainability Planning

Sustainability planning and assessment efforts can be useful at many levels—community, state, ecoregional, watershed, national, and international. The geopolitical level at which efforts are accomplished greatly impacts the process and the results. Local preferences and perceptions are at the (most specific) end of the scale, while external "experts" and scientific standards of validity are at the other (most general) end of the scale. Local communities are less interested in comparability of indicators across cities on a national or international basis (Brugmann 1996); they are interested in solving specific local problems. International efforts seek to develop a rigorous set of widely applicable indicators.

Sustainability efforts at one level need not preclude other efforts. Many sustainability problems are global in nature. It may require an international effort to define the global impacts of environmental issues such as climate change. Global efforts can also draw attention to critical issues, galvanizing international treaties and inspiring local efforts. For example, the Rio Earth Summit spawned treaties on climate change and biological diversity, a set of forestry principles, and Agenda 21, which in turn motivated numerous local Agenda 21 efforts.

Another reason for international programs is for comparison or rating purposes. The *Living Planet Report* is a global effort that stresses the environmental aspects of sustainability, with some attention to socioeconomic aspects. It contains the Living Planet Index (LPI) and the Ecological Footprint for 151 countries. The LPI measures the natural wealth of the earth's forests, freshwater ecosystems, oceans, and coasts and is compared to a baseline of 1970. The Ecological Footprint estimates the amount of biologically productive land required to sustain a population, given the size of that population and its use of resources. While the LPI gives an overall evaluation of the Earth's natural ecosystems, the Ecological Footprint allows a comparison between countries. An Ecological Footprint has been developed by the National Aeronautic and Space Administration (NASA) as a means of baselining and monitoring NASA's impacts. NASA's Ecological Footprint incorporates the air impacts from the energy, transportation, and facilities sectors (Alcorn and Higuchi 2006).

International efforts are more likely to rely on available data. The need for investments in data creation and gathering mechanisms was identified during creation of the Environmental Sustainability Index (ESI). This is an effort of the Yale Center for Environmental Law and Policy (YCELP) in collaboration with the Center for International Earth Science Information Network (CIESIN) at Columbia University and the World Economic Forum's Global Leaders for Tomorrow (GLT) Environment Task Force. This was an attempt to make comparisons of environmental progress between countries with an analytical approach to environmental decisionmaking. The ESI balances both national and global perspectives and includes environmental and socioeconomic aspects of sustainability. This index was intended to apply to a wide range of situations and conditions and to make use of existing measurements while leaving room for what should be measured in the future (YCELP 2001).

National sustainability efforts are needed because many policies on sustainability are made or implemented nationally. Many international agreements need national-level information to help establish international standards. The Sustainable Development Indicators (SDI) Group led an effort to foster discussion on a proposed set of national indicators for the United States. The group took its membership from a cross-section of Federal agencies. The SDI indicator list was meant to provide an awareness of opportunities and problems as an input to decision-making. Comments were solicited from within the Federal government as well as externally from corporate executives, non-governmental organizations, and high school students, all of whom were active in sustainable development. The draft indicator list was also open for public review and comment.

The Army and the DoD also evaluate and address sustainability at the national level. Overall Army policy is developed and applied nationally. Policy documents currently being developed incorporate the triple bottom line of mission, environment, and community. Planning and organizing tactical and support military units occurs at the national level. National analyses allow an overall assessment of vulnerability to sustainability issues and a comparison between installations' and regions' strengths and weaknesses in supporting varying military missions.

At the highest echelon, sustainability planning is driven by the Army. One of the Army's national efforts is the Sustainable Range Program (SRP). The SRP is the Army's overall approach for improving the way in which it designs, manages, and uses its ranges to ensure long-term sustainability. The SRP integrates all management disciplines that affect or are affected by live training and testing. SRP is defined by its two core programs, the Range and Training Land Program (RTLP) and the Integrated Training Area Management (ITAM) Program, which focus on the doctrinal capability of the Army's ranges and training land. The SRP will ensure that the Army's ranges and land assets are capable, available, and accessible to support readiness—indefinitely.

Many Army programs address specific sustainability issues. These include the National Resource Management Plans (NRMP) program, National Environmental Policy Act (NEPA) implementation, and the goals that emerged from the National Energy Policy Act of 2005.

The Sustainable Installations Regional Resource Assessment (SIRRA) tool was developed as a national-level screening tool for the DoD. SIRRA pro-

vides a simplified national assessment of sustainability across 10 issues: air quality, air space demand, energy, urban development, threatened and endangered species, location, water, economy, quality of life, and infrastructure. The SIRRA methodology rates the regions surrounding military installations in terms of risk to sustainability due to 54 individual sustainability indicators. The SIRRA tool uses existing national data sources. Statistical analyses were completed for each indicator, where required, to assign sustainability thresholds and ratings. The data was then mapped into geographic information system (GIS) coverages for individual indicators coded as red, amber, or green. SIRRA was used in this effort to conduct initial screening on the study region.

To the extent that policy is implemented at the local level, it is important that the processes that drive policy on the regional or national levels also occur locally. Support for indicators can only be expected if a locality has a stake in their development. More than 1,500 local governments from 49 countries have established "Local Agenda 21" processes to implement the UNCED's Agenda 21. They have recast the original Brundtland Commission definition of sustainable development to highlight its local management implications (Brugmann 1996).

In local level sustainability efforts, individual parts of the system are specified in detail. The parts are then linked together to form larger components, which are in turn linked until a complete system is formed. Installation initiatives are excellent examples of these efforts. In fact, many DoD installations engage in some form of installation sustainability planning strategy where the installation initiates policies and partnerships in an effort to maintain the military mission. Strategies based on the installation-generated information flow are necessary because they are based on the knowledge of all variables that may affect the elements of the system. Yet, they are often costly to the installation to implement. It can also be difficult to sustain momentum.

Within DoD, specialized local sustainability efforts have also taken place. One example of this is the Installation Sustainability Planning (ISP) process first initiated at Fort Bragg in 2000. Since then the ISP process is either complete or in progress at 16 Army installations. Although the ISP process is guided by sustainability experts and facilitators from outside the post, each sustainability roadmap is developed by a diverse group of local stakeholders. Like the SSA, the ISP process is a case of spiral development,

where sustainability goals are periodically reviewed and modified to reflect changing conditions and strategic interventions.

In September 2004, a group of strategic planners and environmental staff from installations and headquarters began efforts to institutionalize an installation strategic planning process for IMA installations, based on experience with sustainability planning at six pilot installations. The IMA ABCDEFG model guides installations through the ISP process in 18 months. This has been documented in *The Guide to Creating a Sustainable Installation in 25 Years or Less*. Official training and guidance for the resulting Installation Management Agency "strategic planning for sustainability" process is available through URL:

http://www.envquest.com.

Other requests on Army Sustainability are available through URL:

http://www.sustainability.army.mil

Regional Sustainability Planning Efforts

The sustainability issues that impact the Army's triple bottom line often do not lend themselves to either national or local sustainability planning and assessment efforts. While national efforts are useful for comparisons between regions, the scale of data required to conduct a national assessment is often too large to inform local sustainability efforts. It can also be fruitless to strive for sustainability inside the installation fenceline while activities outside the gate render military efforts ineffective. The spatial distribution of adverse effects lies somewhere in between these two geographic extremes. Sustainability planning and assessment is ideally carried out on a regional basis by a diverse set of stakeholders both on and off post.

The concept of region, indeed, seems intrinsic to the thought patterns of contemporary humans, especially in western, industrialized nations. Regional planning is often undertaken with the presumption that there is an inherent understanding of the meaning of the terms "region" and "regional." In spite of its wide usage, "region" is a difficult word to apply. Regions have been used by governmental agencies and others to delineate multi-jurisdictional areas, such as those comprised of more than one town, city, county, state, or nation. Natural scientists use regions in reference to a part of the surface of the earth, such as watersheds, physiographic provinces, climate zones, or faunal areas. Geographers define a region as an uninterrupted area possessing a kind of homogeneity in its core, but lack-

ing clearly defined limits. Even standard dictionary definitions are ambiguous: any more or less extensive, contiguous part of a surface of space.

Regions may be political, economic, bio-physical, and/or sociocultural. The fundamental problem is that regional boundaries and scales greatly vary based on definition. Therefore, it can be difficult to define a region in which to measure environmental, social, and mission interactions.

The Fall Line Region was chosen for the prototype regional sustainability assessment because of its distinct physical and geological characteristics, the diversity of its military activities, and the considerable efforts that are underway to understand, characterize, and restore ecosystem management. Appendix A gives a Ecoregion Description of the Fall Line Region.

The efforts underway to understand, characterize, and catalog the Fall Line environmental data have mostly been conducted at the installation level and were initiated to combat issues impacting its mission. These include Installation Sustainability Planning (ISP) initiatives at Fort Bragg, Fort Benning, and Fort Jackson, and a host of installation comprehensive planning efforts. Specialized efforts aimed at one issue (e.g., threatened or endangered species) pertain to the extent of the species habitat. The Joint Land Use Study (JLUS) at Fort Bragg, NC is completed and is in progress at Fort Benning, GA.

Several organizations and coalitions have undertaken projects specific to the region or parts of the region. These include The Southeastern Ecological Framework, The Georgia Project, the SERDP Ecosystem Management Project (SEMP), Sustainable Sandhills, The Natural Resources Management Plan hosted by The Savannah River Site, The Conservation Fund in partnership with the Golden Leaf Foundation, and the Georgia Project. Some of these programs are broad in scope and others address specific critical sustainability issues. A brief description of these programs follows, and Appendix D provides more details.

Southeastern Ecological Framework

The Southeastern U.S. Ecological Framework Project (SEF) was conducted in 1999-2000 by the University of Florida GeoPlan Center, and sponsored by the U.S. Environmental Protection Agency (USEPA) Region 4. SEF is a GIS-based analysis to identify ecologically significant areas and connectivity in Florida, Georgia, Alabama, Mississippi, South Carolina, North Carolina, Tennessee, and Kentucky. The intent is that the product(s) of

this study can be used by local, state and Federal agencies in developing a regional atlas of environmental issues and conflicts and threats to the natural ecosystems caused by human environmental impacts. State, local and private entities can use the information to address various environmental resource allocation issues.

The Georgia Project

SERDP Ecosystem Management Program (SEMP)

SEMP was created as a new SERDP project to pursue research relevant to DoD ecosystem management concerns. critical knowledge gaps in understanding ecosystem status, especially as they relate to military land management concerns. The two major SEMP objectives are "change indicators" and "disturbance thresholds." These areas resulted in the Ecosystem Characterization and Monitoring Initiative (ECMI) and Determination of Indicators of Ecological Change.

The host site for SEMP is Fort Benning, GA and its environs. Partnering organizations include ERDC, the University of Florida, Prescott College, and Oak Ridge National Laboratory. Outcomes from the research efforts are procedures, analysis tools, publications, and workshops aimed at improving our understanding of ecological processes and mission interactions with these processes on military lands. Monitoring and repository approaches at host sites are transferable components of SEMP, as well as outcomes from the research projects. Workshops with host installations (and other installation land/water managers) are a regular part of the technology review and transfer process. SEMP maintains a database and library of publications.

Sustainable Sandhills

The Sustainable Sandhills Initiative is an off-shoot of Fort Bragg's ISP effort. The Sandhills of North Carolina is a region that balances environmental, economic, military, and social needs for all in the region. Sustainable Sandhills is a region-based coalition that shares a vision and collaborative actions. Their goals are to preserve natural resources, enhance economic development, and improve the quality of life for current and future generations.

Golden Leaf Foundation/The Conservation Fund

The Golden Leaf Foundation is working with The Conservation Fund to help low- and moderate-income farmers. Retention of lands adjacent to military installations as farmlands serves to reduce the risk of encroachment around military bases while helping landowners with conservation techniques and economic tools and resources.

4 Process

Process Overview

This report investigates how installations in the Fall Line Ecoregion can overcome specific encroachment concerns and begin to develop sustainable management plans. The regional assessment process relies on a combination of forecasting and backcasting methods. Forecasting summarizes expectations about what will happen in the future. Conversely, backcasting analyses determine a desired future and how that future can be attained in light of present conditions and possible future scenarios. Figure 1 shows a model of the forecasting and backcasting process (adapted from generic backcasting method presented in *Futures Under Glass* [Robinson 1990]). The model is cyclical, and implies continuous process improvements. That is, improvements are continually being made-through the cycle of developing scenarios, modeling alternative futures, conducting gap analyses, determining policy changes, and revising goals and targets.

A full justification for this process may be found in ERDC/CERL Special Report (SR) 05-12, *Considerations for the Development of the Strategic Sustainability Assessment Program*. However, the basic reasoning recognizes that it is unrealistic for analysts to know all the conditions at the onset. This assumption creates a need for too many details early in the project—requiring more time, data, and labor. It is more effective to begin with a generalized profile of the region and its conditions and then to advance with greater sophistication into key forces and key issues that have been identified. Not only does this allow for selective detail of issues, but also regions. As the initial literature review revealed, dynamics of encroachment issues vary drastically between regions. Preliminary assessment with a simple model can provide quick screening of encroachment conditions and identify the criteria for more advanced modeling.

Forecasting is intended to predict future outcomes. The two distinct methods of forecasting are “judgmental” and “statistical.” Judgmental forecasting involves experts and works best when quantifiable data is lacking or of poor quality. Statistical forecasting methods explore trends within existing quantitative data. Extrapolation is the most common statistical method used in environmental forecasting.

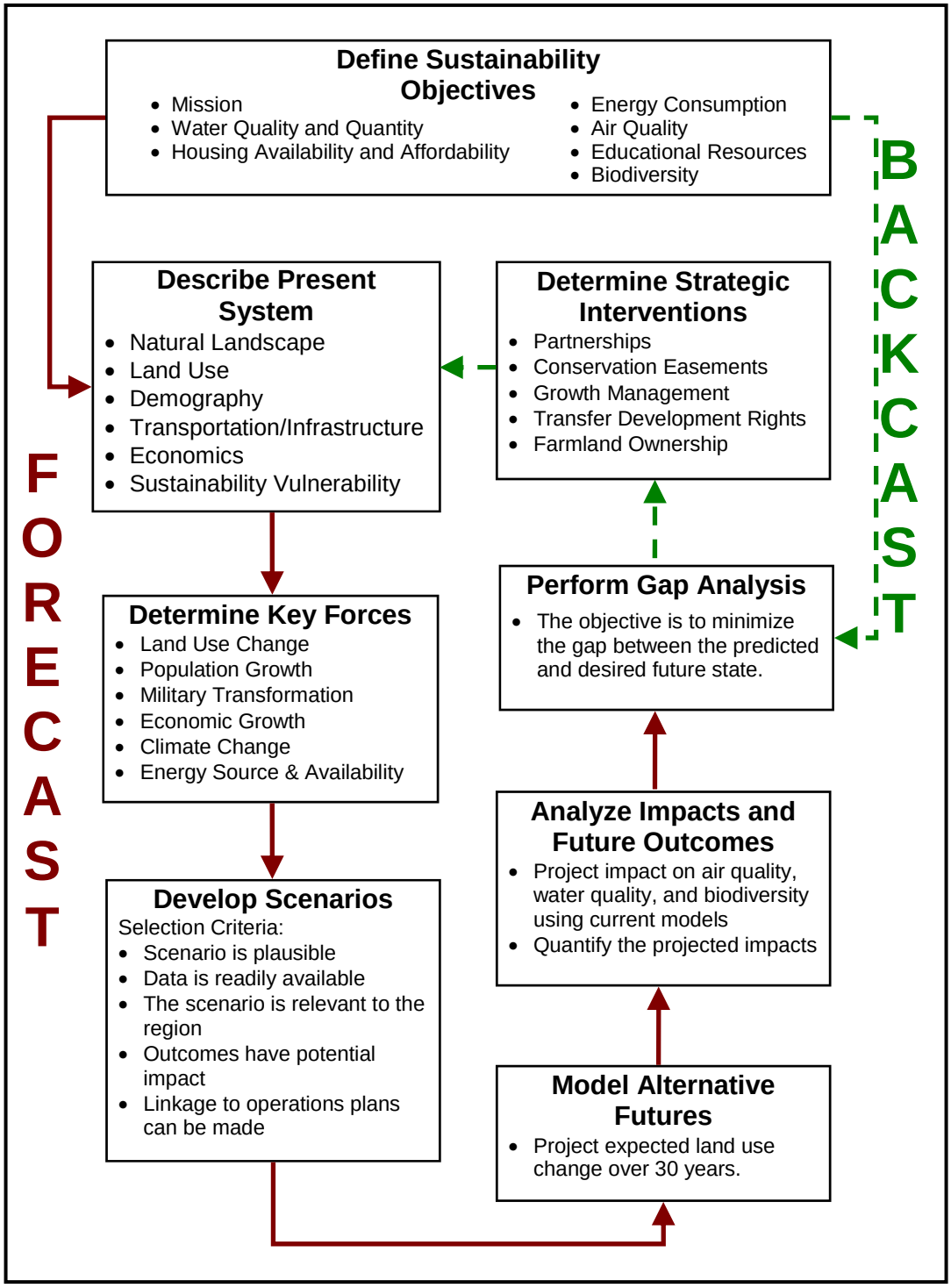


Figure 1. Process flow chart.

Forecasting using extrapolation is appropriate to use when indicators can be expected to operate as they have in the past. Modeling the future has become significantly more sophisticated in the last 20 years. Complex relationships can be defined and aggregated to determine outcomes. Models

may be linked and results from one model put into another to expand the breadth of issues covered in the modeling process.

Backcasting is a technique where the desired future state is defined and then the analysis progresses backwards from that particular desirable future to the present to determine the feasibility of that future and what policy measures would be required to reach that point. The difference between the desired end state and the end state that scenarios predict, defines the fertile ground for policy change and course correction. Therefore, backcasting and forecasting are complementary, especially in situations where great change is needed to achieve the desired outcomes. Backcasting is especially appropriate where trends are leading towards an undesired state. Forecasting methods can inform the analyst when backcasting is required.

Define Sustainability Objectives

Sustainability objectives were identified from local and regional organizations; installation goals and comprehensive plans; national goals, orders, and laws; best practices, and Army policy. A list of critical sustainability issues was used as a guide to select goals and objectives for study within this report. Certain issues are recurrent across Army installations and are generally agreed on as key events to maintaining readiness. The issues selected were energy consumption; water use and quality; housing availability and affordability; and educational resources. Specific goals were gleaned from reviewing installation sustainability goals that were developed during the ISP process, most specifically, at Forts Benning and Bragg. Generally, installations in the Fall Line Ecoregion are establishing goals and objectives addressing water use, waste diversion, construction standards, energy consumption, local land use compatibility, and natural and cultural conservation programs. Local objectives in conjunction with JLUS initiatives focus on urban encroachment issues. Appendix D includes example lists of sustainability ISP and JLUS goals and objectives.

The desired future for the Fall Line Ecoregion is based on the achieving sustainability with respect to a set of objectives or key outcomes. The key objectives are air, water, biodiversity, and education. The set of drivers or exogenous variables that impact these outcomes are population and land-use change, energy resource issues, climate change, and Army transformation. The end state objectives defined below are in terms of the environmental outcomes desired. Strategies to achieve them are determined using

backcasting technique to consider the range of actions within and between human and natural systems over time that avoid or respond to the undesirable aspects of the given scenarios.

Sustainability objectives for the Fall Line Ecoregion are:

- *Mission*. The Army is able to carryout is various missions now and in the future. The Army has the land, water, and air resources it needs to train; a healthy environment in which to live; and the support of local communities.
- *Air*. Air quality throughout the region meets ambient standards year-round with no exceptions and there is no degradation from present ambient quality where standards are exceeded. The air is colorless, odorless, and pesticide free. Industry and power plants meet or exceed source performance standards.
- *Water*. Water is plentiful, meets standards, and natural systems are healthy. Watersheds meet standards, wetlands are protected and increased, and stormwater runoff meets standards and is treated and handled throughout the region by natural means that enhance groundwater replenishment and watershed health.
- *Biodiversity*. Biodiversity is increasing, habitat is maintained and growing, TES are recovering, no new species added to TES list, ecological patches are connected through a system of greenways, and public lands are maintained without pesticides.
- *Education*. School agencies meet the required space objectives.
- *Energy*. Energy resources and supplies are adequate to allow the region to sustain is economy within a framework of reliable, secure, domestic, and renewable resources.
- *Housing*. There is a viable stock of affordable and available housing.

Describe Present System

It is necessary to characterize the region as a preliminary step before modeling predicted change. The characterization effort was divided into six functional areas of research: (1) natural landscape, (2) land use, (3) demography, (4) transportation/infrastructure, (5) economics, and (6) vulnerability to sustainability issues. For each study area, data was collected, reviewed, and issues identified. The framework of sustainability demands that each functional area be considered. A 25-mile buffer of the Fall Line Ecoregion (including the ecoregion) served as a set boundary of study (Figure 2).

The application of sustainable development requires that decisionmakers, planners, developers, special interests, and politicians perceive of their

communities as part of a larger system, with the success of any single component dependent on the success of the system.

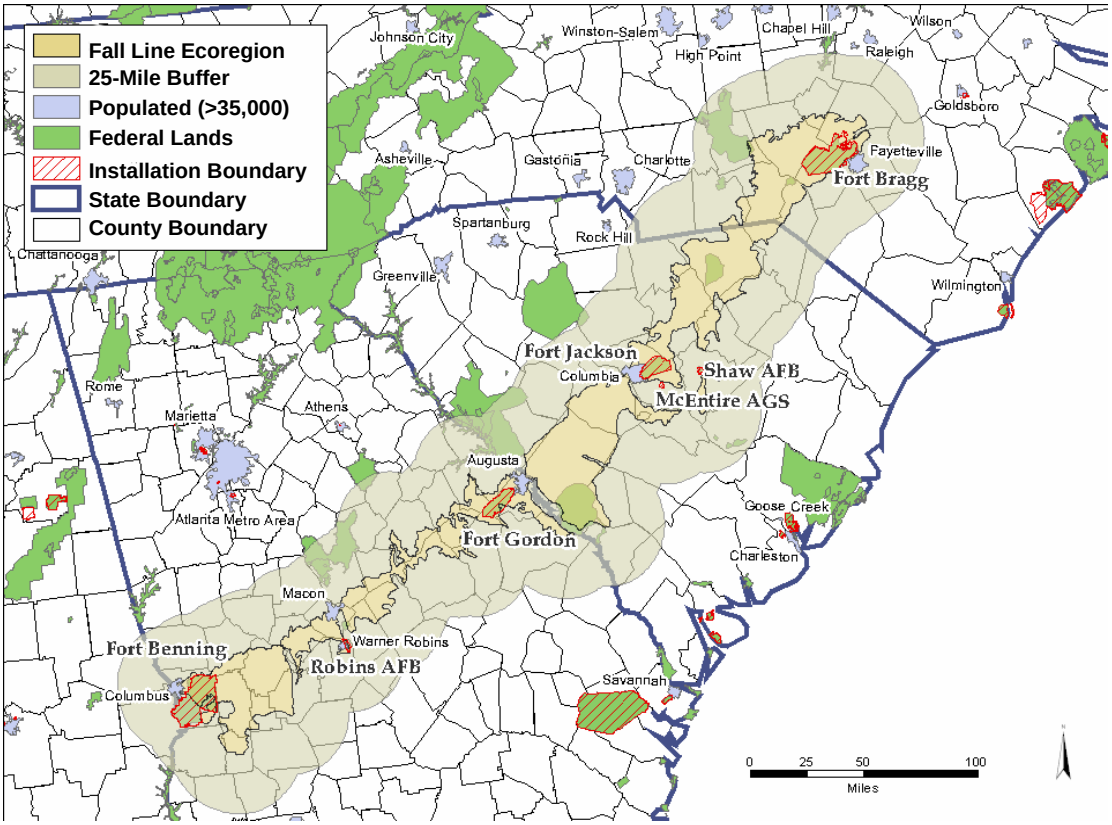


Figure 2. Fall line region.

Therefore, selection of a study region must reflect natural constraints; be based on natural and geographic boundaries; not be artificial or political; and be holistic, interconnected, and participatory. These parameters lead to the expanded look at the Fall Line Ecoregion as the focus study region. Thus, the Fall Line Region (ecoregion and 25-mile buffer) serves as the starting point from which existing conditions, trends, and patterns can be characterized.

Natural Landscape

The Fall Line Ecoregion, whose eastern border is composed of a narrow ribbon of Sandhills, stretches north from Phoenix City, AL, through Columbus, Georgia, and Columbia, South Carolina, to Fayetteville, NC. Historically, the region was the shoreline of the Atlantic Ocean during the Mesozoic era. As the Earth transformed in the later half of this era, the ocean floor rose and eroded much of what was the coastal sandstone. Today, this eroded sandstone remains as Sandhills. The Fall Line separates

the Piedmont from the risen Atlantic Coastal Plains. Here, upland rivers "fall" to the lower Atlantic coastal Plains. Land of the Atlantic Coastal Plains rises gradually from the southeast to the northwest. It consists of swamps, forests, and fertile soils. The Piedmont is a 100-mile wide belt between the Blue Ridge Mountains and the Sandhills. The landscape consists of rolling hills; gentler in the east (400 to 1,200 ft above sea level) and more hilly to the west and northwest (1,400 ft above sea level) (South Carolina State Museum 2004).

The differences in geology to the northwest and southeast of the Fall Line give rise to differences in soil types, hydrology, and stream morphology. Sandy soils and wide flood plains predominate to the southeast of the Fall Line, whereas clay soils and narrower stream valleys are the rule to the northwest (Nature Conservancy 2004). A consequence of these differences is that the Fall Line is a geological boundary—separating significantly different plant and animal communities. At one time, the Fall Line region was almost a contiguous belt of pine and oak dominated woodlands. A succession of land uses beginning with agriculture and grazing, progressing through timbering and extensive silviculture to intensive silviculture, urban development, and military training (on the installations) has resulted in shifts in the fire regime of the region and thus a more highly fragmented landscape, which has significantly influenced the regional habitat composition and quality (Nature Conservancy 2004). Appendix A gives a full description of the Fall Line Ecoregion geology.

The ecoregional boundary is itself a natural barrier for plant and animal species habitat as well as general land uses. Additional barriers within the Region include watershed boundaries, rivers (Chattahoochee, Savannah, and PeeDee), national forests (Sandhills National Wildlife Refuge, Sandhills State Forest, major portion of the Savannah River Site, and Hitchcock Woods), and the physical drop of the fall line. Watershed boundaries are important because they affect water supply and allocation, and dictate flows of waterways and determine where rainfall is collected.

Land Use

The Fall Line Region comprises approximately 8,036 sq mi of land, which encompasses 52 counties—26 in Georgia, 17 in South Carolina, 9 in North Carolina, and 1 in Alabama, measuring approximately 349 miles long and 50 miles wide. The Chattahoochee, Savannah, and Pee Dee Rivers cross the region. Surrounding metropolitan areas include Atlanta and Savannah, Georgia and Charlotte, NC. DoD installations in the region include Fort

Benning, Robbins AFB, and Fort Gordon in Georgia; the U.S. Department of Energy (USDOE) Savannah River Site (SRS), Fort Jackson, and Shaw AFB in South Carolina; and Fort Bragg and Pope AFB in North Carolina. DoD lands comprise nearly 548 sq mi (Fort Benning and Fort Bragg being the largest).

Historically, the Region was primarily a rural landscape—distant from urban areas. Over time, however, the establishment of military installations drew people and business closer and closer to take advantage of civilian job opportunities offered by the installation and to provide the goods and services to support the installation's operations. The series of slides in Figure 3 shows population growth in the Sandhills regional counties from 1900 to 2000. Military installations appear in the slides during the decade they were established. These maps indicate that population growth within the Fall Line Region occurred *first* adjacent to military installations.

Much of the rural areas within the Fall Line Region consist of longleaf pine woodlands. This ecosystem is associated with threatened, endangered, and sensitive species (TES) (e.g., red-cockaded woodpecker, gopher tortoise), forest commodities (e.g., timber, pine straw) production, and DoD training and testing. Urbanization within the Region has impacted the integrity of longleaf pine woodlands in terms of TES habitat, fire regimes, hydrologic patterns, soil stability, and groundcover integrity.

There are a number of areas identified as ecologically sensitive, which will undoubtedly affect existing and future development patterns—including national forests and wetlands. An example of this type of boundary is the Chattahoochee River, which is located on the western border of the Region near Fort Benning, GA. The Chattahoochee River is essential to the water supply of Georgia, Alabama, and Florida, and is currently protected due to water quality issues.

Demography

Over 3,797,755 people live within counties located within the Fall Line Region according to 2000 U.S. Census data. At current growth rates, well over 5 million are expected by 2030. The Region is comprised of urban, suburban, and rural communities each with unique demographic characteristics. Focusing on the three major urban areas within the Region—Columbus, Georgia; Columbia, South Carolina; and Fayetteville, NC—populations grew 4.0 percent in Columbus, 18.6 percent in Columbia, and 59.9 percent in Fayetteville between 1990 and 2000.

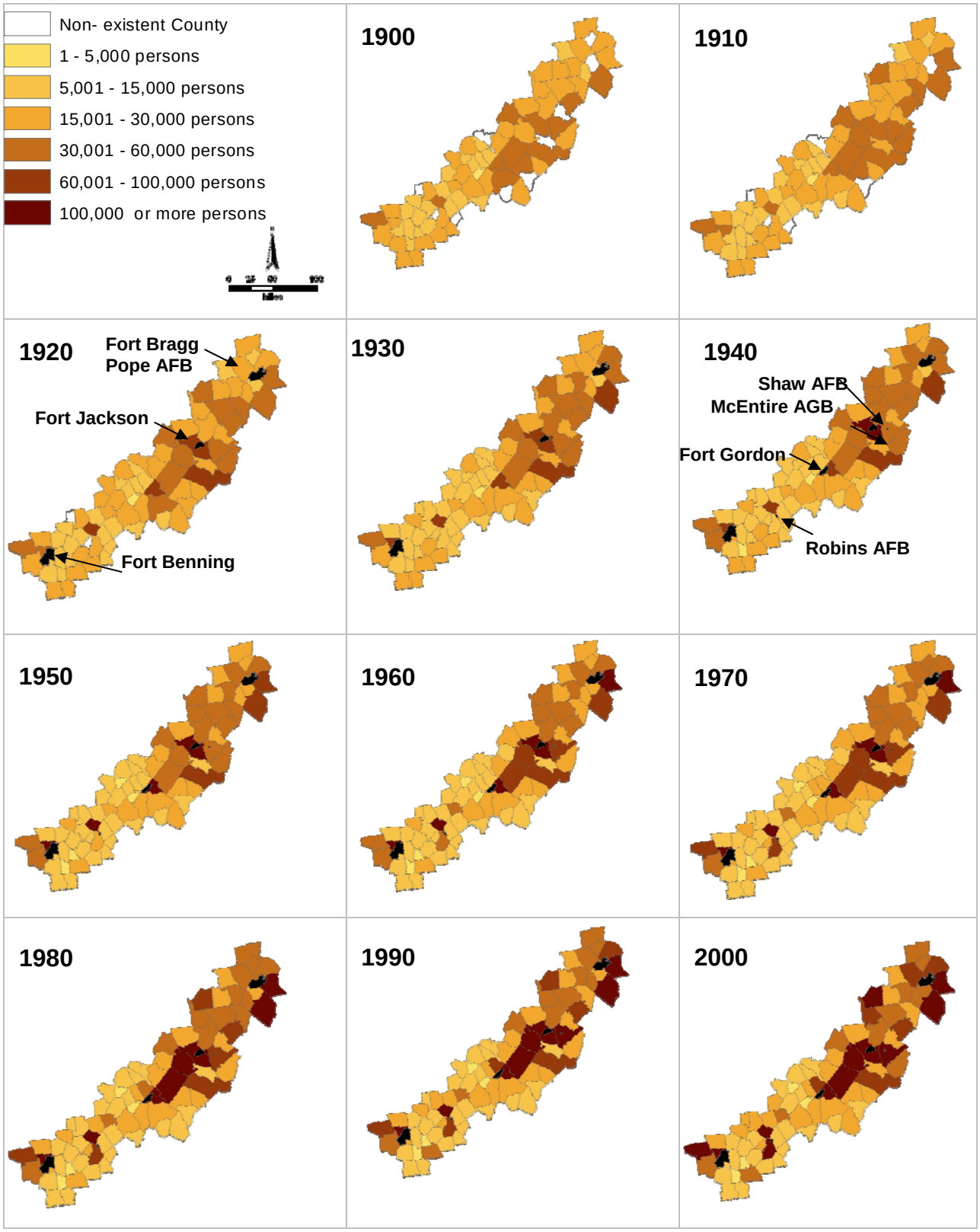


Figure 3. Fall line regional population.

Overall U.S. populations grew just over 13 percent during this time frame. The rates of growth within each area vary greatly, yet for all the differences, there are many similarities. Racial composition averages 49 percent Caucasian and 44 percent African American in all three communities. Household incomes average $34,853 in Columbus, $31,141 in Columbia, and $36,287 in Fayetteville—all of which are below the national average of $41,994. 79.0 percent of Columbus', 82.3 percent of Columbia's, and 84.8 percent of Fayetteville's population have at least a high school diploma. This compares to a national average of 80.4 percent. Commute times to work average 26 minutes in the United States and range from 21 minutes in Columbus, 19 minutes in Columbia, and 22 minutes in Fayetteville (U.S. Census Bureau, 1990-2000). Generally, the Region is greatly impoverished compared to national averages. Unemployment is of particular concern within the South Carolina counties, and crime rates well exceed national averages within South Carolina and North Carolina counties.

Transportation/Infrastructure

An additional influence on development patterns are transportation investments. The southeast region's patterns of development have largely been shaped by the natural environment and transportation investments. Natural forests are one example of natural features restricting development. Here, protections ensure no development will occur, which inhibits linkages and connections across the area. A current transportation investment making a significant difference in regional connectivity is the "Fall Line Freeway." In Georgia, the U.S. 80 High Priority Corridor is part of a proposal called the Fall Line Freeway. Although referred to as a freeway, it will be constructed to multi-lane divided standards initially. Georgia DOT refers to this corridor as Project FLF-540, indicating both the name of the highway and the future state route number, Georgia 540. According to Georgia DOT, the Fall Line Freeway is a part of the 1989 Governor's Road Improvement Program (GRIP) that would run from Columbus to Macon to Augusta. The Fall Line Freeway is estimated to cost $287 million, should be completed by 2009, and will provide a direct corridor from Columbus to Augusta. The goal of the GRIP is to connect 95 percent of the state's cities with a population of 2,500 or more to the Interstate system via four-lane roads and to put 75 percent of the state's population within 2 miles of a four-lane highway. The Fall Line Freeway will follow improved existing routes: the Fall Line Freeway follows U.S. 80 from Columbus to Geneva, then it follows Georgia 96 from Geneva to Interstate 75, goes up Interstate 75 to Macon, then follows Georgia 49, 57, 22, and 88 up to Interstate 520 on the outskirts of Augusta. Like other high priority corridors,

it is anticipated that the Fall Line Freeway will bring economic benefits to the rural regions of Georgia, as evidenced by articles related to the project, such as the Macon Telegraph article, "Driven to prosperity: Midstate counties banking on Fall Line Freeway," by Rob Peecher on 27 June 1999.

Economics

Each of the Fall Line Region's urban, suburban, and rural areas has its own unique economic base and drivers. Together, they create a diverse economy. Yet overall, soil characteristics within the ecoregion caused the Region to fail in the predominating agricultural economies of the adjoining states. Thus, the economy turned to lumbering. This resulted in a large fraction of the landscape devoid of topsoil. Soil erosion and the resulting sedimentation remains one of the Region's most intractable challenges. By World War II, the government was looking for affordable land to develop military training installations. The failed farmland of the Sandhills turned out to be ideal and the DoD has been a predominant economic figure in the region ever since.

Vulnerability to Sustainability Issues

The SIRRA™ screening tool was used to assess the vulnerability of the Fall Line region to 54 sustainability indicators in 10 issue areas: (1) air quality; (2) airspace; (3) energy; (4) urban development; (5) threatened and endangered species; (6) locational issues; (7) water; (8) economics; (9) quality of life; and, (10) transportation. Each issue area is comprised of a set of indicators. SIRRA™ draws data from open, well documented, national level sources, such as the U.S. Geological Survey, Bureau of Census, NatureServe, and the USEPA. This evaluation provides for a heightened awareness of long-term issues that could threaten mission sustainment. Although best used as a national screening tool, SIRRA™ provides a useful means of assessing not only the specific military installations included in this assessment, but also depicts the vulnerability of adjacent regions. This can warn of an adverse trend that is near by, but not yet in the study region. A discussion of each issue area follows. Appendix C includes SIRRA™ data maps for the Sandhills/Fall Line Region. More information and metadata files documenting each indicator are available on the SIRRA™ web site through URL:

https://ff.cecer.Army.mil/ff/sirramx.doc

Air Quality Sustainability

The Clean Air Act provides the principal framework for national, state, tribal, and local efforts to protect air quality. Under the Clean Air Act, the USEPA establishes air quality standards to protect public health by setting National Attainment Air Quality Standards for the six principal pollutants that are considered harmful to public health and environment and ensuring that these air quality standards and strategies to control air pollutant emissions from vehicles, factories, and other sources. The vast majority of the Fall Line Region is in attainment of USEPA air quality emission standards. However, the greater Atlanta region (adjacent to the northwest Fall Line Region) is a non-attainment zone. As the Atlanta Metropolitan Statistical Area (MSA) continues to grow, its population and higher emissions are creeping into the Fall Line Region and posing a threat to the air quality.

Concerning noise levels within air spaces, it is recognized that noise complaints have a direct relationship with population concentrations. Theoretically, noise complaints have a greater chance of occurring near civilian development. Any section of an installation located within or near a civilian population is considered sensitive or vulnerable to noise complaints. Each military installation located within the Fall Line Region is located adjacent to an urban population. Current populations range from 21,295 persons at Shaw AFB to 139,892 persons at Fort Benning within a 3-mile buffer of an installation. A population under 100,000 is considered to be a low vulnerability. Robins AFB, Fort Gordon, and Shaw AFB are the only installations within the Fall Line Region meeting the low vulnerability criterion. It is critical for the improved quality of life for both military personnel and the residents of the regions surrounding military installations that noise levels be monitored.

Airspace Sustainability

Having available airspace is typically a necessity of military shipments, mobilization, and training. Inadequate access places the installation in a vulnerable state, affecting mobilization or, possibly, the type and intensity of training that could take place. Airspace structure is complex. The Federal Aviation Administration regulates aircraft based on altitudes as well as through the development of Special Use Airspace (SUA). SUAs were developed to advise pilots of an activity or surface area that dictates special rules or notices and may possibly be hazardous. There are numerous types of SUAs. Those primarily used by the military include Military Operations

Areas (MOA) and Military Training Routes (MTR). All installations within the Fall Line Region have adequate access to SUAs and MTRs. However, access to this airspace is often restricted due to the presence of terminal airspace—airspace regulated by an approach control service or airport traffic control service. The rapid population growth within the Fall Line Region and resulting expansion of local airports has increased regional air traffic demands. Installations within the Fall Line Region will likely experience restrictions on desired traffic routes due to arrival/departure overloads and/or frequency of en route aircraft. The percentage of terminal airspace within 20 miles of an installation ranges from 15 to 65 percent within the Fall Line Region. To sustain airspace accessibility, installations prefer no terminal airspace within 20 miles.

Energy Sustainability

The Fall Line Region received three low vulnerability, two high vulnerability, and two mixed or average vulnerability ratings out of the seven energy indicators. Average and high vulnerability rating for solar and wind renewable energy leave biomass as the only viable renewable energy source for the Region:

- Electrical grid reserve capacity is a critical issue for the entire Region. The *Electrical Grid Congestion* indicator measures the percentage of capacity margin for the North American Electricity Reliability Council (NERC) regions for the summer of 2010. For the Fall Line Region, the possibility of future power shortages is great.
- *Net Metering* indicates whether a state allows non-energy producers, such as consumers, to sell excess electrical energy produced on-site back to the grid at the local rate. The implications of this indicator are whether or not the state is progressive in its approach to integrated resource planning and management. Currently, Georgia is the only Fall Line state with net metering regulations.
- Low electrical grid congestion and no deregulation of utilities are positive impacts within the Region. Utility deregulation is considered a high vulnerability. This is because electrical infrastructure has not been maintained in states where electrical utility deregulation is in place. The power outage of August 2003 occurred in states where electrical utilities are deregulated.

Urban Development Sustainability

Although growth rates tend to have an average to low sustainability vulnerability, regional population densities are at or slightly above the national average throughout the region. Populations have tended to cluster around installations to take advantage of civilian job opportunities offered

by the installation and to provide the goods and services to support the installation's operations. Thus, urbanization and proximities to MSAs are a concern for all Fall Line Region military installations. Of the eight installations within the Fall Line Region, six have completed or are in the process of completing a JLUS (Fort Bragg, Pope AFB, Shaw AFB, and Robins AFB, Fort Benning, and Fort Gordon). The presence of a JLUS indicates an effort between the local community and the military installation to work together. Additionally, each state within the Fall Line Region has completed moderate to substantial state smart growth plans.

Threatened and Endangered Species Sustainability

Much of the region faces two or more aquatic species at risk. North of the Fall Line Federally listed and Species of Concern occur at a density less than the national average. However, south of the Fall Line is home to 0.00079 to 0.00102 species/sq mi, earning an average or slightly above average sustainability vulnerability rating. The Fall Line Region supports a unique flora and fauna, including a suite of rare or uncommon plant and animal species. Data supports addressing the habitat sensitivities of these species along with demands associated with military training and other land-use activities.

Locational Sustainability

The only highly vulnerable sustainability locational issue is Seismicity Zones. The Fall Line Region lies within a zone rated greater than 24 spectral response acceleration for 0.2 second period (5 percent of critical damping) with 2 percent probability of exceedance in 50 years.

Federally declared floods, *Federally declared disasters*, *weather related damage*, and *tornadoes* all tend to have low sustainability vulnerability ratings within the Region.

Water Sustainability

There are several different indicators included in water sustainability. Average vulnerability ratings were received for *Level of Development, Flood Risk, Low Flow Sensitivity, and Water Quality*. The *Level of Development* indicator measures the ratio of current water withdrawal to mean annual unregulated stream flow. An average vulnerability rating equates to a ratio between 20 and 85 percent. A value of less than 20 percent would be needed to attain a low vulnerability rating. Areas along the North Carolina

and South Carolina border and within most of Georgia already have a value of less than 20 percent development.

The *Flood Risk* indicator, based on the current population living within a 500-year flood plain, characterizes the extent to which lives and, to a large degree, property are at risk of flood damages. An average rating characterizes areas with 20,000 to 200,000 residents within the 500-year flood plain. Most of South Carolina and Georgia have less than 20,000 people living within a 500-year flood plain.

The *Low Flow Sensitivity* indicator measures unregulated mean streamflow. Streamflow is defined as the mean value of discharge that occurs in a natural channel. This measurement is mostly independent of levels and changes in surface runoff. Overall, streamflow is >0.236 cu ft^2/s. However, a segment within Georgia experiences streamflows between 0.065 and 0.236 cu ft^2/s. No watershed within the Fall Line Region experiences high streamflow sustainability vulnerabilities (less than 0.065 cu ft^2/s).

The *Water Quality* indicator was derived from USEPA data contained in the Index of Water Indicators (IWI), which involves an assessment of condition, vulnerability, and data sufficiency. The Fall Line Region was generally rated Less Serious Water Quality Problems and Low Vulnerability.

Economic Sustainability

The indicators under economic sustainability primarily had high or average sustainability vulnerabilities with the exception of *Housing Affordability*. *Unemployment* and *Poverty* have severe sustainability vulnerabilities throughout the Region. Characteristics of the labor market and income level reveal much about the economy and quality of life of a community. Although the job market and salaries may not seem to affect service members, it will affect their family members and the overall economic growth of the area. Unemployment rates average 7 percent within the Region, but exceed 9 percent up to 19.8 percent in scattered counties throughout the Region. A rate between 4 and 5.7 percent is most desirable. Poverty rates often exceed 18.4 percent of the population. Less than 12 percent of the population in poverty is most sustainable.

The DoD is a major influence in the local economy due to the large number of DoD employees within the region. The *DoD Local Employment* indicator is a measure of the percentage of military employment within a county's total employment. It is assumed that the higher the percentage of

military employment within an economy, the more likely the DoD will be looked on as a friend and field fewer complaints pertaining to stationing and mission decisions. It is believed that the military installations provide many benefits to their local region in terms of economic impact.

The *Average Housing Value of New Construction* is comparable to the national average—between $74,000 and $100,000 per unit. However, the number of residential building permits issued form 1995 to 2004 climbed over 300 percent in many areas directly surrounding military installations. This may be an indicator of expected regional growth.

Quality of Life Sustainability

Overall, the Fall Line Region is highly vulnerable to quality of life sustainability. Crime, healthcare, and education are vital concerns for much of the Region.

Crime Rate is a particular concern within the Carolina segment of the Fall Line Region. However, it teeters between high and low vulnerability throughout the Region. Crime rates must be below 46 crimes per 1,000 persons to be considered low vulnerability. Much of the Carolinas exceed 77 crimes per 1,000 persons.

Healthcare Availability, *Educational Attainment*, and *Commute Times* are generally poor. However, scattered areas (primarily around DoD installations) rate high in these areas and are thereby relatively less vulnerable to sustainability concerns.

Housing Availability is low throughout the region while rental availability is high. Availability is measured through vacancy rates provided by the U.S. Census Bureau. There are an increasing number of military members and families living off-base due primarily to the current housing policy of maximizing reliance on civilian housing. Thus, local housing availability is an important indicator in determining DoD stationing attractiveness and quality of life for military employees and their family.

Transportation Sustainability

Overall, transportation issues are not highly vulnerable within the Fall Line Region. Of the seven indicators, none exceeded national averages or standards.

There are numerous airports located within the Fall Line Region where total annual enplanements are less than 3,005,916 persons. This implies available airspace capacity. Since the indicator is a measure of the number of people using the airspace and not the number of aircraft using the airspace, local knowledge of activity patterns must be understood in interpreting the capacity classifications of commercial airports. It may be concluded that military installations within the Fall Line Region have adequate access to C-5 and C-141 aircraft suitable airports. Railroad and Interstate access are also suitable for both civilian and military communities.

Though traffic volumes do not pose sustainment problems, *Roadway Congestion* has average sustainment vulnerabilities within the Region. Road congestion is defined by the Federal Highway Administration's Roadway Congestion Index (RCI). RCI is a function of traffic volume, road segment length, number of lanes in the road segment, and is calculated at the state level. Given that the data is collected at the state level (not community or installation), it may be skewed by local "hotspots." In other words, if a state has one roadway with relatively high congestion rates, the entire state may be classified as high roadway congestion regardless of the characteristics of the remaining majority of the state. Because of this concern, it is important to use local knowledge in interpreting the roadway congestion classifications.

Determine Key Forces

Having defined the region of interest, a systematic list of key forces was developed. The Fall Line Region is large, but is still affected by adjacent region impacts. These include laws and regulations created at the state level, national weather patterns, and national energy trends. Each key force, concept, or indicator has its uniquely defined region—contiguous or non-contiguous (sometimes referred to as a "problem shed"). How these regions interact with respect to the key forces is a major component of forecasting and trending.

Determining the stressors that impact the regional environment required an examination of the key forces likely to change over the next 20 to 30 years along with the enduring trends affecting urbanization and growth. These likely critical factors or key forces are: land-use change; population growth and development patterns; climate change; military transformation and realignments; and the availability and price of energy resources, which may alter the current development paradigm. Over time, the action

of these forces will shape sustainability outcomes. Sustainability outcomes of interest are impacts on the availability and quality of water and the health of watersheds, changes in habitat and biodiversity including impacts on threatened and endangered species, and effects on air quality. These key forces were modeled based on a set of assumptions for the Fall Line region using a set of scenarios. The impacts of these forces on sustainability outcomes related to the Fall Line Region are discussed later in this report.

Demographics and Land-use Change

According to the U.S. Department of Agriculture's National Resources Inventory (NRI), developed land in the contiguous United States increased by 34.5 million acres, or 47 percent, between 1982 and 2002 (NRCS 2004). This means that almost one-third of all of the land converted from rural to urban and suburban uses since European settlement occurred in only 20 years. This 34.5-million-acre expansion represents an area roughly the size of the State of North Carolina. During the same 15-year period, between 1982 and 2002, population grew by about 24 percent (Census Bureau 2003). Thus, land consumption occurred at about twice the underlying rate of population growth. In addition, the mismatch between land development and population growth is widening. Between 1982 and 1992, land was developed at 1.8 times the rate of population growth. During the period between 1992 and 2002, that multiple had grown to 2.03. Since 2002, the growth rate has slowed slightly.

One of the drivers for this high rate of land conversion was due to significant reductions in household size. This requires more dwelling units to house the same population. This inherent growth of households is then exacerbated by population growth, relocations, and increasing home sizes. Changes in household size and the number of households in the study area have shown similar or even higher trends than those nation-wide. For example, the average household size in Georgia, North Carolina, and South Carolina dropped from 2.71 to 2.56, or about 5.5 percent from 1990 to 2000. During this same period, the national average household size dropped about 4.1 percent. Also, during that period, the national population rose by 13.2 percent, while the population in the states along the Fall Line grew by 20.8 percent.

Between 2002 and 2030, the population of the nation is projected to grow by 29.2 percent. During the same time period, the population in the study region is projected to grow 51.9 percent in North Carolina, 46.8 percent in

Georgia, and 28.3 percent in South Carolina All rates are significantly above the national norm. If the relationship between land use and population in the last decade continues, there will be 45 million more acres of developed land in the contiguous United States than exist today. This newly developed acreage—equivalent to the land area of North Dakota—will be more than half the amount of land developed from the founding of the country until 1983. With much of the growth projected to occur in the South, a significant portion of this changed land will lie in that region.

The impact of land conversion is greatly magnified because the coasts host more than half of the U.S. population on less than one-fifth the nation's land area. In 1982, developed land covered 53 million acres, or 3 percent of the non-coastal watersheds in the contiguous United States In contrast, 10 percent of the acreage of coastal watersheds was developed. By 1997, 71 million acres, or 4.2 percent, of the interior of the United States was developed. The coastal portion had risen to 27 million acres, or 13.7 percent of the land area. In contrast, development covered no more than 10.5 percent of any region's non-coastal watersheds. The most obvious manifestation of growth is the physical expansion of metropolitan regions and coastal resort areas. This expansion of developed land and paved surfaces is unprecedented and its continuation will have disastrous effects on coastal ecosystems. Development in coastal watersheds degrades the creeks and marshes that run through them. Once pavement and roofs cover 10 percent of a watershed's acreage, the health of aquatic ecosystems begins to decline (Klein 1979).

The two-fold effect of population growth and continued reductions in development density indicate significant habitat and environmental impacts over the next 25 years unless development patterns change markedly. It appears that sprawl has accelerated over the last decade and may be now slowing, but ways to steer growth and development on a more benign path have not had significant effect as yet. Scenarios must consider the current trends and more benign paths to establish a set of bounds for future development impacts.

Climate Change

In general, it is very likely that North America will get substantially warmer. Temperatures are projected to rise more rapidly in the next 100 years than in the last 10,000 years (Cohen, Miller et al. 2001). North America has warmed by about 0.7 °C during the past century and precipitation has increased, but both trends are regionally varied and there have

been seasonal reductions in precipitation in some areas. The recent Pew Center report provides compelling evidence that ecosystems are already responding to climate change (Parmesan and Galbraith 2004). Warmer temperatures have resulted in longer growing seasons at the national level, altered carbon cycling and storage in the Alaskan tundra, and increased frequency of fires and other disturbances in U.S. forests. North America could warm by 1–3 °C over the next century for a low-emissions case. Warming could be as much as 3.5–7.5 °C for the higher emission case (Cohen, Miller et al. 2001). In the Arctic, warming has actually been much greater than expected and the ice sheet has shrunk by nearly 40 percent over the last 35 years. The summer ice coverage has shrunk by 15 to 20 percent in the last 30 years (Arctic Climate Impact Assessment 2004). The recent ACIA study indicates that by the end of the century there might be no ice left in the Arctic Ocean in the summertime. Northern ocean water density and salinity is dropping, leading to possible impacts on the thermohaline circulation currents.

It is also very likely that there will be more precipitation overall, with more of it coming in heavy downpours. In spite of this, some areas are likely to get drier as increased evaporation due to higher temperatures outpaces increased precipitation. Droughts and flash floods are likely to become more frequent and intense.

In North America, climate change is expected to increase the extent of forested lands over the next 50 to 100 years. Climate change is likely to cause changes in the nature and extent of incidences such as fire and insect outbreaks. Also expected are changes in fire regimes, including an earlier start to the fire season, and significant increases in the area experiencing high to extreme fire danger. Climate change will also lead to loss of specific ecosystem types, such as high alpine areas and specific coastal and inland wetland types.

Potential impacts of climate change include fewer periods of extreme winter cold; increased frequency of extreme heat; rising sea levels and risk of storm surge; and changes in timing, frequency, and severity of flooding associated with storms and precipitation extremes. These changes in the frequency, severity, and duration of extreme events may be among the most important risks associated with climate change. The rising cost of natural disasters in North America illustrates the vulnerability of current settlement practices (CBO 2002). Human alterations of natural systems—such as drainage basins, barrier islands, and coastal margins—influence

the impact of extreme weather hazards. Adaptations such as levees and dams often are successful in managing most variations in the weather, but they can increase vulnerability to the most extreme events as was seen during the 2005 hurricane season in the Atlantic basin with the impacts of Hurricanes Katrina and Rita.

The impacts noted above are based on gradual climate change where there exists time for adaptation and adjustments to the economy and ecological systems. Another potential response from the climate system is abrupt climate change. Until recently, the dominant view of climate change was that the climate system changed gradually in response to the processes noted above. Evidence now shows that climate has changed much more rapidly in the past and this rather abrupt change is likely to occur again in the future with large impacts on ecosystems and societies (National Research Council 2004). The expected future warming may come smoothly or it may come in jumps with short-lived or local cooling, floods or droughts, and other unexpected changes. Societies and ecosystems are not well suited to deal with the abruptness and unpredictability of the possible changes. There is a possibility that gradual global warming could lead to a relatively abrupt slowing of the ocean's thermohaline conveyor, leading to harsher winter weather, sharply reduced soil moisture, and more intense winds (Schwartz and Randall 2003). Thus, there would be some regional cooling, but overall, the Earth would still be warmer on average.

The major impacts of abrupt climate change are most likely to occur when economic or ecological systems cross important thresholds and move to a different climate regime. A notable aspect of abrupt global and regional climate change is significant departures from normal precipitation levels. Precipitation is inherently more variable than temperature. Paleoclimatic records show that extreme and persistent droughts have occurred throughout the past few millennia in widespread regions. The recognition of abrupt changes in the past reinforces concerns about anthropogenic climate change. Current and expected trends have the potential to push the climate system across a threshold to a new state. This abrupt change to a new climate state occurs at a rate determined by the climate system itself. The rate of change in climate is often significantly greater than the rate of change in the causal factors for that region.

Energy Resource Issues

Petroleum products and natural gas represent about two-thirds of the nation's energy supply. The domestic outlook for both of these energy

sources is problematic with price and availability issues certain to have major impacts on the economy and bring about significant energy policy changes and technology shifts in the next 30 years. Trends indicate price spikes, disruptions, and shocks may strike the general economy as the world energy situation plays out. A recent bipartisan commission on energy policy released its report on the national energy situation (NCEP 2004). The report recommends a slate of energy research, efficiency, and production initiatives to address the anticipated energy challenges. The World Energy Outlook indicates that an investment of $16 trillion dollars is required to meet expected energy demands world-wide through 2030 (IEA 2004).

Another important consideration is how current development and land use paradigms are related to the availability and price of petroleum products. Much of the energy requirements in the United States are related to development patterns and higher prices will alter these patterns to a more sustainable paradigm. Continued development in the present sprawl paradigm will result in unsustainable energy usage patterns.

Develop Scenario

Developing scenarios that project future impacts of the key stressors over a 20 to 30 year period requires restricting the modeling to sub-regions of the study area. In total, four scenarios were developed for modeling. Scenarios require specific input drivers and defined assumptions and must meet the following criteria to be considered for the project:

- Required data is available and readily accessed.
- Scenario is plausible and a forecast can be made.
- The scenario is relevant to the region.
- Outcomes have potential mission impact.
- Linkage to operations plans can be made.

Scenario 1: Status Quo Population Growth

The first models the status quo of the sub-regions surrounding Fort Bragg, Fort Benning, and Fort Jackson (temporal and spatial projection of land use changes and impacts in the region over the next 25 to 30 years based on “business as usual” assumptions) using the Landuse Evolution Assessment Model (LEAM™) model. The scenario assumes the completion of the Fall Line highway (which is already complete from Columbus to Macon). Population projections are based on U.S. Census Bureau projections and development patterns of the present continuing in the future. This meth-

odology will provide land-use change patterns. Impacts are developed based on the changes in land-use. These include demands for water and energy, automobile density and use, water quality changes, and habitat disruption.

Scenario 2: BRAC 2005 Impacts

The second scenario models the Columbus, GA area to determine impacts of the recommended closures and realignments transmitted by the Secretary of Defense to the Congress on 13 May 2005. Recommendations at Fort Benning include the impact of realigning Fort Knox, KY, by relocating the Armor Center and School to Fort Benning, GA, to accommodate the activation of an Infantry Brigade Combat Team (BCT) at Fort Knox, KY. In addition, engineer, military police, and combat service support units from Europe and Korea are being relocated to Benning under the Defense Department's Integrated Global Presence and Basing Strategy (IGPBS). Specific numbers of military, family members, DoD civilian, and contractor personnel being accommodated at Fort Benning, along with expected dates of the plus-ups, were "best guess" estimates developed by the Fort Benning Base Realignment and Closure (BRAC) coordination office. This information could change, but still illustrates the impact a large number of new personnel can have on a region. Table 1 lists this data for Fiscal Years 2006-2011 (FY06-11).

The numbers of family members affiliated with DoD civilian employees and contractors was taken from demographic statistics obtained from the Census Bureau. As such, these are programmed into LEAM™. Military family members were determined using U.S. Army Human Resources Command (formerly known as the Personnel Command [PERSCOM]) averages. Armor School students leave family members at their home post during training, therefore, carry no family members.

Table 1. Expected increase in military population at Fort Benning, FY06-11.

Year	Military	Mil FM	Civilian	Civ FM	Contractors	Cont FM	Students	Students FM
FY05		0						0
FY06	185	337						0
FY07		0	100		200		853	0
FY08		0	100		200		853	0
FY09	3276	5962	500		900		7724	0
FY10	66	120						0
FY11	135	246						0
	3662	6665	700	0	1300	0	9430	0
FM = Family Members								

Scenario 3: Impact of Regional Growth on Air Quality and Energy Resources

The third scenario considers the greater regional growth and development in the Fall Line region. This scenario incorporates the expected development expansion and energy consumption changes in the region providing a scenario basis for evaluating air quality in the region over the next 25 years. The land use change and economic growth scenario will provide input to projections of regional energy use and emissions. Information and modeling from the Fall-line Air Quality Study (FAQS) will also inform the scenario (Russell, Odman, et al. 2001). Energy resource issues will be evaluated as well as electric grid implications and the societal costs of the expanded energy use.

Scenario 4: Abrupt Climate Change

The final scenario considers abrupt climate change in the region associated with a breakdown of the thermohaline ocean conveyer system. The scenario assumes an average annual temperature drop of 5 degrees Fahrenheit from 2015-2025. Associated with this will be persistent drought throughout the southeastern United States. The impacts on the watersheds due to the extended drought will be evaluated.

5 Alternative Futures

Predicting the future of a region is much more difficult than documenting historic land use change and sustainability indicators, or describing the current status. The intended and unintended consequences of public policy and investment choices, especially across a large region, are often the result of very complex interactions among a number of factors. A thorough understanding of these consequences is vital to good planning. Urban land use models that capture these complex interactions can simulate some of these consequences.

Modeling Land Use Change in the Fall Line Region

The LEAM™ modeling tool was chosen to forecast land use change over a 30-year time period, from the base year of 2000 to 2030. LEAM™ has been used previously to model the area surrounding Fort Benning as well as the Scott Air Force Base region in Missouri. LEAM™ has also been applied to non-military regions in Kane County and Peoria, IL and to the greater St. Louis metropolitan area.

The Fall Line Region is too large to be modeled in its entirety using LEAM™ Reasons for this include diversity between economic, societal, and environmental factors throughout the Region. Other reasons are: time and energy constraints gathering data and computing power to run the model for a stretch of land covering three states. Factors such as household size and expected population growth vary within the Ecoregion. Therefore, the LEAM™ model would need to be run independently on each sub-region to capture these variances. There is also a practical reason for not modeling the entire region. Population growth, and consequently land use change, has occurred historically in discrete areas within the Region. These areas coincide with the location of military installations. It is most critical to understand the areas where the greatest amount of change is expected and therefore mitigation strategies are most needed and would have the greatest impact.

Due to the extreme data, time, and computing power needs of running the LEAM™ model for the entire Fall Line Region, the model was run on three selected multi-county areas within the Region—the areas surrounding Fort Benning, Fort Bragg, and Fort Jackson. This also allowed for the model to

be calibrated specific to the characteristics of these sub-regions and thus better assist in local planning efforts.

Additional benefits of limiting LEAM™ modeling to sub-regions include the ability to incorporate previous work generated within the sub-regions into the current modeling effort and to tailor the outputs to specific needs within the sub-regions, such as the Installation Sustainability Planning (ISP) processes. One goal of the SSA project is to assist where possible with installation sustainability planning. Each of the aforementioned installations is at a different phase in its ISP process. Fort Bragg completed the five-phase ISP process in 2003, although true to the cyclical nature of the process, their efforts in improving sustainability are ongoing. Fort Benning is at the mid-point of their ISP process. A draft set of goals was completed in May 2005. Fort Jackson began their ISP process in 2005.

As efforts are completed within respective sub-regions, more detailed data becomes available to incorporate into further modeling. For example, an economic model was developed for the Fort Benning sub-region under the SERDP project, providing a greater degree of accuracy to the LEAM™ growth model. Much corporate knowledge was available for Benning and the installation staff was supportive of efforts to update previous modeling. Modeling sub-regions also allowed a realistic projection of impacts.

LEAM™

LEAM™ is a computer-based tool that simulates land use change across space and time. Planners, policy makers, interest groups, and laypersons use LEAM™ to visualize and test the impact of various policy decisions. The LEAM™ system is designed to enhance our understanding of the connections between urban, environmental, social, and economic systems.

LEAM™ breaks down the geographic region of interest into 30-square-meter cells (approximately a quarter of an acre). Each cell changes in response to activity around the cell and to various drivers of growth. These drivers are forces that cause land use changes to occur in some places and not in others. The resulting land-use transformations are then analyzed for environmental impacts such as changes to air, water, or species habitat. Sustainability indices provide guidance on the assessment of the impacts.

This model is a powerful planning tool, created to assist in the development of regionally based thinking. It helps describe the future and the implications of current decisions on future activities. The intent is to help co-

ordinate complex regional planning activities. This application can help to promote regional thinking and a greater understanding of the potential land-use and subsequent encroachment issues facing the Fall Line Region. This is accomplished in part by providing local stakeholders the ability to examine current and future public policies and investments that may lead to a more sustainable region.

The LEAM™ tool has the ability to run multiple scenarios to aid decision-making. Scenario ideas are generated by local policymakers and stakeholders. Altering input parameters (different policies, trends, and unexpected events) changes the spatial outcome of the scenario being studied. This enables what-if planning scenarios that can be visually examined and interpreted for each simulation exercise.

The products of LEAM™ model runs are analyses of a series of policy scenarios, presented as GIS maps or movies that show the transformation of the subject landscape as a product of policy related inputs. These dynamic visual outputs are beneficial for testing policy scenarios and raising concerns regarding the impacts of development, environmental degradation, or conflicting land-use policies. Further integration of scenario results and impact assessments allow for a number of presentation methods including simulation movies, maps, graph or chart displays, and as raw data for user analyses.

To capture land-use transformation dynamics, LEAM™ begins with eight land-use transformation drivers—economic, population, social, geography, transport, open space, neighborhood, and random. These drivers capture the forces that contribute to urban land-use transformation decisions. The model drivers describe land-use transformation probabilities. Each driver is developed as a sub-model; definitions are completed and run independently of the larger LEAM™ organization. Variables of interest can be scaled and plotted in formats that help visualize sub-model behavior so contextual experts can calibrate and test sub-model behavior before it becomes integrated into the larger model.

Drivers include:

- *Regional economic projections*, which determine how many jobs and people are expected to change in the future.
- *Residential land demand*, which affects demand for residential development based on population projections and projected changes in household size, new residential lot size, and vacancy rates.

- *Cities Attractor*, which causes new development to occur near current cities; the larger the city, the more development it attracts.
- *Transportation*, which causes new development to occur near highway ramps and major intersections on highways and county roads.
- *Slope*, which discourages new development on steep slopes.
- *Water*, which attracts new open space development
- *Nearest Neighbor Development*, which causes new development to locate close to existing development.
- *Utilities*, which cause new development to primarily occur where municipal services are available.
- *No-Growth Zones*, which prevent new development from military bases, forest preserves, and other protected existing uses.

Modeling Alternative Futures

Results of LEAM's growth projection modeling are output maps of land use related to each of the defined sub-region and their project scenarios. Maps are representative of land cover for 2030, the last year of the model run. Appendix C includes a land cover map for 5-year increments of the model run period. Time series maps allow for land use change analysis and corresponding impact analysis to be conducted for actions and the time of implementation.

The following pages provide summary output maps. Summary output maps indicate where new development is projected to occur in the Fort Benning, Fort Bragg, and Fort Jackson sub-regions during the 30-year modeling time period. "Zooming in" on a specific parts of a summary map can provide a more detailed picture of what is occurring along the installation boundary.

Results are also summarized in spreadsheets and graphs that indicate where growth occurred over time in the sub-regions and the land uses that declined as urbanization increased. Tables show that some counties will have significant increases in development over the next few years, but growth will slowly decline over time. Other counties will see more development occur 20 to 30 years from now. Tables also indicate that forest and agricultural land will decline significantly as a result of urbanization. These results give local stakeholders a perspective on what the model projects the future will hold for the sub-regions in terms of where it will occur and how it will impact other land uses.

Benning Sub-Region Land Use Change Maps

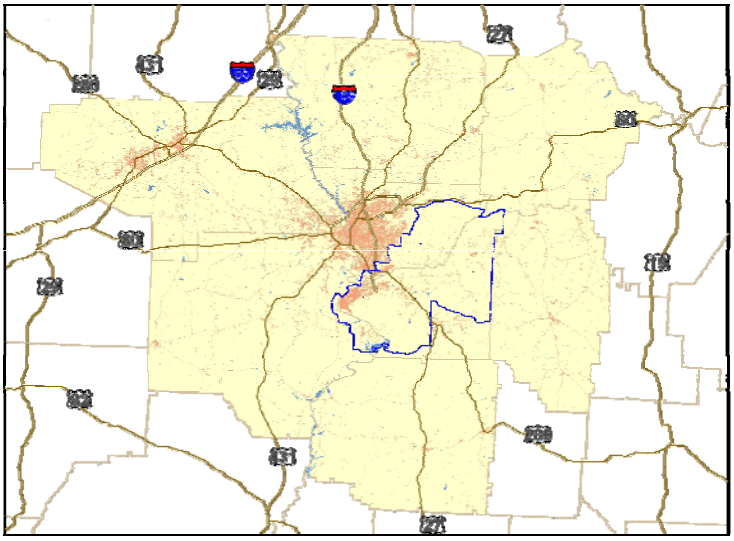
Business as Usual

Figure 4 shows maps presenting the results of simulations that project the future growth of urban areas in the region of Fort Benning. The counties included in this model are: Lee, Talbot, Stewart, Muscogee, Marion, Harris, and Chattahoochee in Georgia and Russell in Alabama. The simulation uses the set of generic drivers and assumes "business-as usual" economic and demographic trends continue as they have in recent past. The first model simulation assumes a population growth rate of 2.2 percent/year, for a total increase of 19.3 percent, which is the U.S. Census Bureau estimate based on historical trends. In this scenario population in the region increases by about 151,000; residential development increases about 42,000 acres; and commercial development increases by 7,000 acres. There is a corresponding decrease in open space land use. Agriculture lands decrease by about 10,000 acres and forest decreases by 38,000 acres. Appendix F details land use change by county.

The first figure shows regional land use for the base year of 2000. Developed land—which includes residential, commercial, and industrial—is shown in tan (Figure 4 and Table 2). The second map shows land use in the year 2030 as projected with the LEAM™ model. This map shows existing developed land as tan, new residential as yellow, and new commercial/industrial as red. The last map shows the location of new growth dramatically in purple. Note the large proportion of new development that occurs to the north and west of Columbus, GA, and the large developments to the southeast of Fort Benning. Growth generally occurs adjacent to existing developed land and along roads.

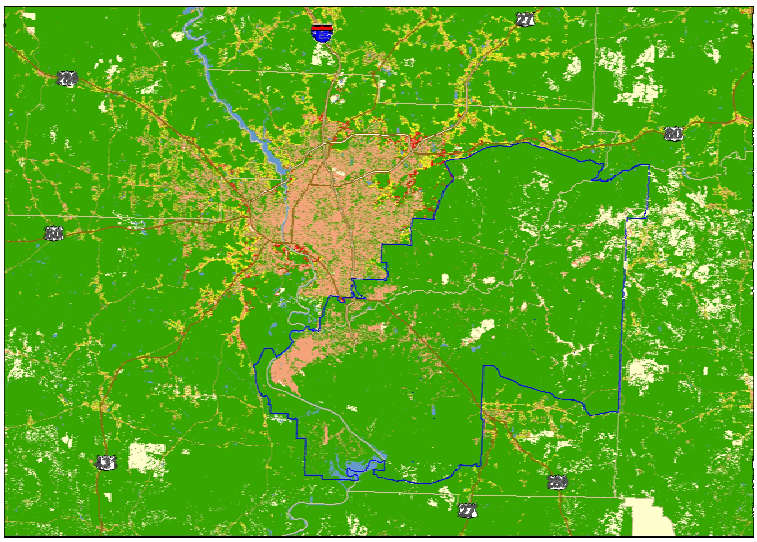
High Growth

In this scenario population in the region increases by about 338,000; residential development increases about 75,000 acres; and commercial development increases by 13,000 acres. There is a corresponding decrease in open space land use. Agriculture lands decrease by about 19,000 acres and forest decreases by nearly 68,000 acres (Figures 5 and 6, and Table 2). Appendix F details land use change by county.



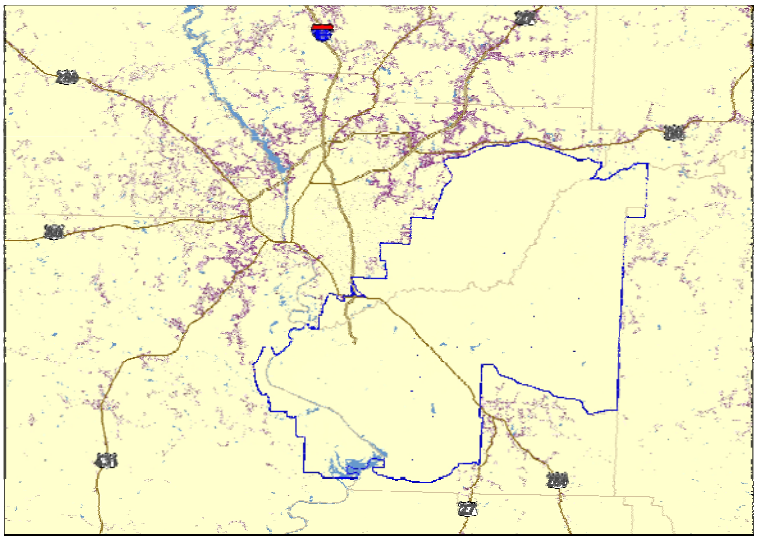
Fort Benning Sub-Region
Landuse 2000

- Interstate
- Highway
- County Boundary
- Installation Boundary
- Developed
- Sub-Region
- Water
- NORTH



Fort Benning Sub-Region
Landuse 2030
Business as Usual

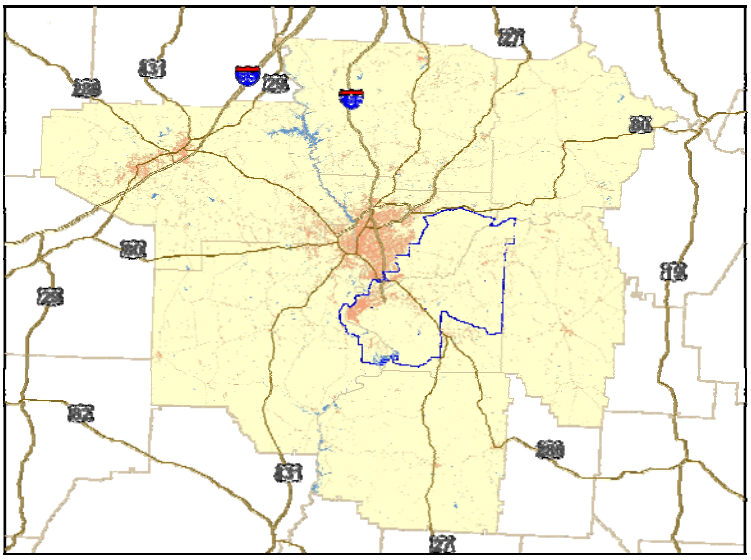
- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Residential
- New Commercial
- Developed
- Forest
- Other
- Water
- NORTH



Fort Benning Sub-Region
Change in Landuse 2000-2030
Business as Usual

- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Development
- Sub-Region
- Water
- NORTH

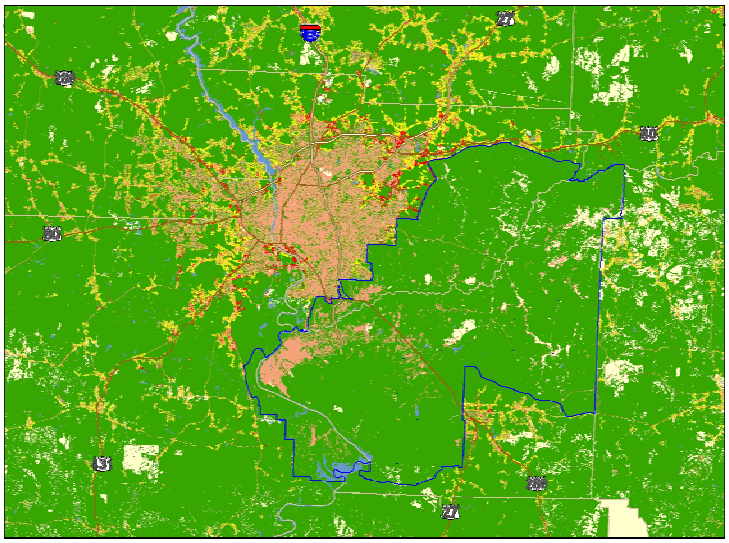
Figure 4. Fort Benning business and usual land use change scenario.



Fort Benning Sub-Region
Landuse 2000

- Interstate
- Highway
- County Boundary
- Installation Boundary
- Developed
- Sub-Region
- Water

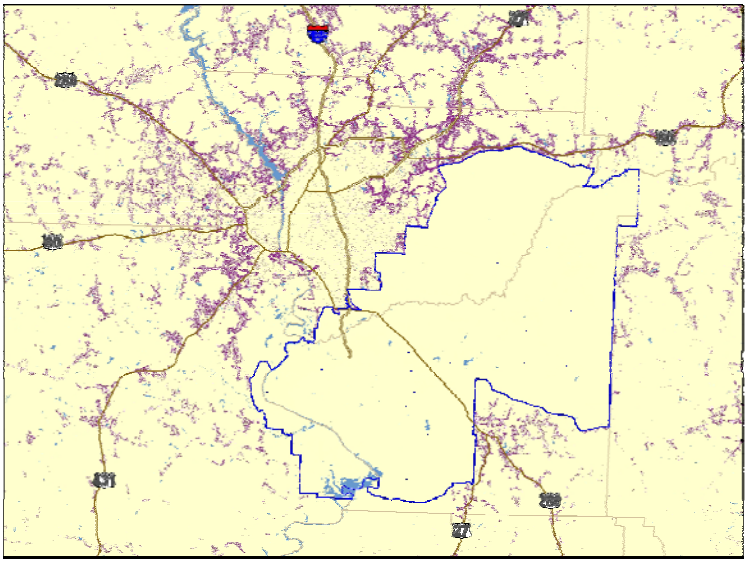
NORTH



Fort Benning Sub-Region
Landuse 2030
High Growth

- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Residential
- New Commercial
- Developed
- Forest
- Other
- Water

NORTH



Fort Benning Sub-Region
Change in Landuse 2000-2030
High Growth

- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Development
- Sub-Region
- Water

NORTH

Figure 5. Fort Benning high growth land use change scenario.

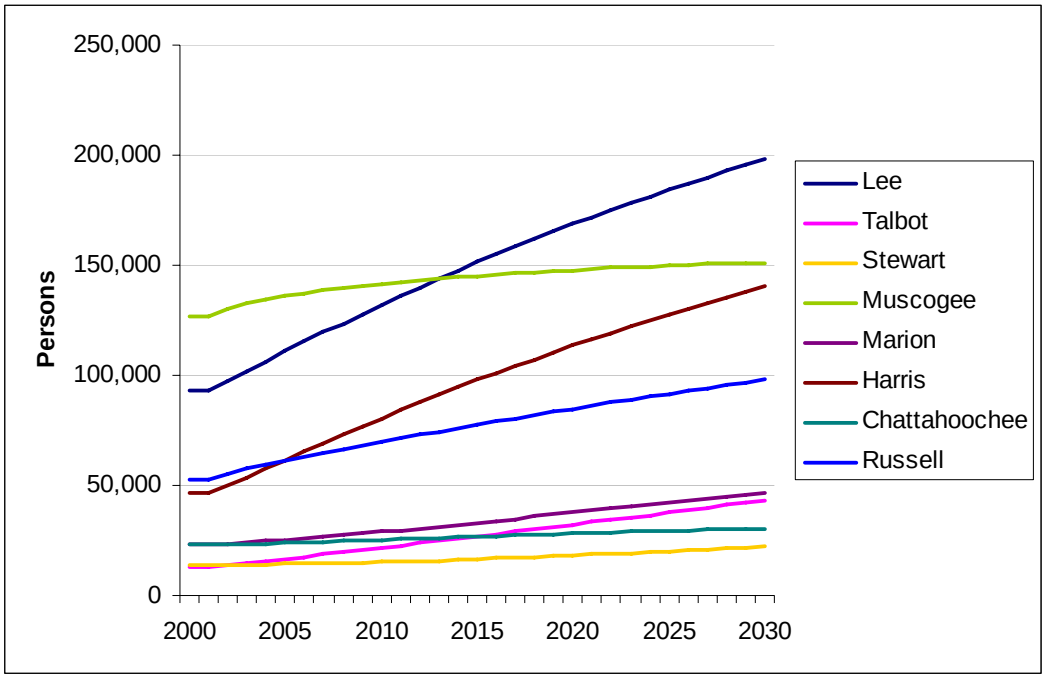
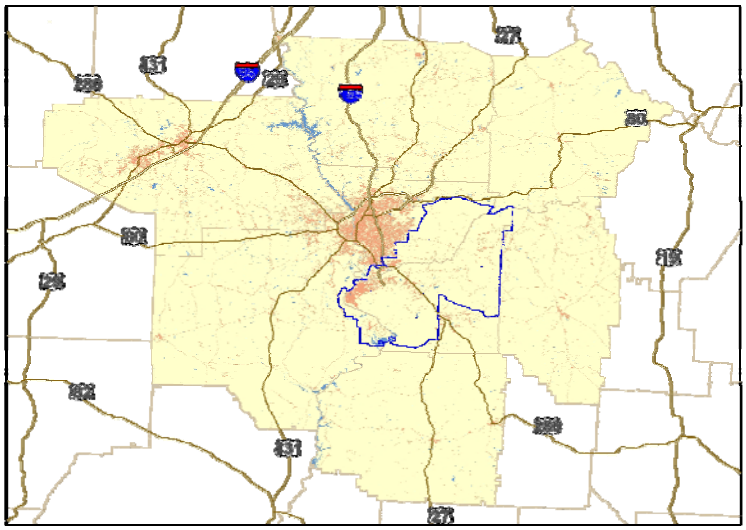


Figure 6. Fort Benning population change high growth scenario.

The first figure shows regional land use for the base year of 2000. Developed land—which includes residential, commercial, and industrial—is shown in tan. The second map shows land use in the year 2030 as projected with the LEAM™ model. This map shows existing developed land as tan, new residential as yellow, and new commercial/industrial as red. The last map shows the location of new growth dramatically in purple. The maps of high growth rate show an increased concentration of developed land. Development to the east of Fort Benning and along Highway 80 to the northeast is more pronounced in the high growth rate simulation.

BRAC Scenario

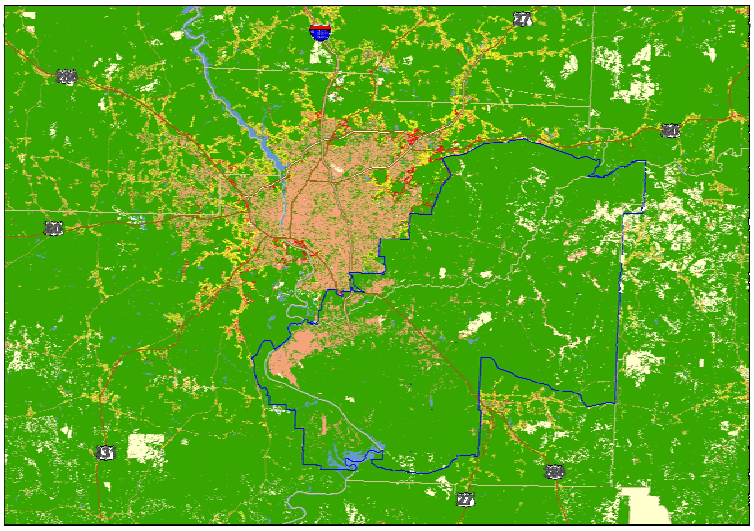
Figure 7 shows land use maps depicting the simulated urban growth in the region due to planned BRAC actions. This scenario assumes that over 5,660 additional troops, civilians, and contractors will be working at Fort Benning between 2006-2011 as a result of BRAC 2005. In addition, three classes per year of 9,430 students will attend the relocated armor school at Fort Benning. Economically this scenario is between "business as usual" and the "high growth" scenarios with little change in the spatial structure of the scenario. The first figure shows regional land use for the base year of 2000.



Fort Benning Sub-Region
Landuse 2000

- Interstate
- Highway
- County Boundary
- Installation Boundary
- Developed
- Sub-Region
- Water

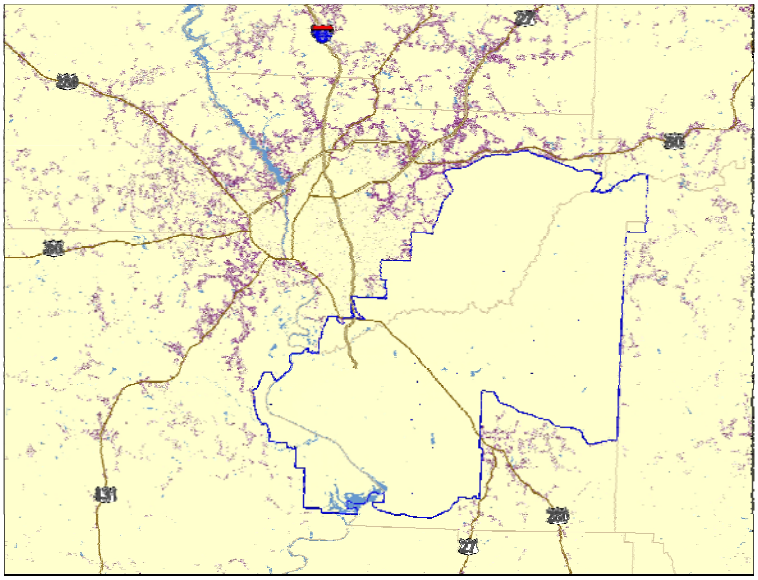
NORTH



Fort Benning Sub-Region
Landuse 2030
Army Transformation

- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Residential
- New Commercial
- Developed
- Forest
- Other
- Water

NORTH



Fort Benning Sub-Region
Change in Landuse 2000-2030
Army Transformation

- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Development
- Sub-Region
- Water

NORTH

Figure 7. Fort Benning Army transformation land use change scenario.

In the BRAC scenario, population in the region increases by about 186,000; residential development increases about 48,000 acres; and commercial development increases by 8,000 acres. There is a corresponding decrease in open space land use. Agriculture lands decrease by about 12,000 acres and forest decreases by nearly 44,000 acres. Developed land—which includes residential, commercial, and industrial—is shown in tan (Figures 7, 8, and 9, Table 2.) The second map shows land use in the year 2030 as projected with the LEAM™ model. This map shows existing developed land as tan, new residential as yellow, and new commercial/industrial as red. The last map shows the location of new growth dramatically in purple.

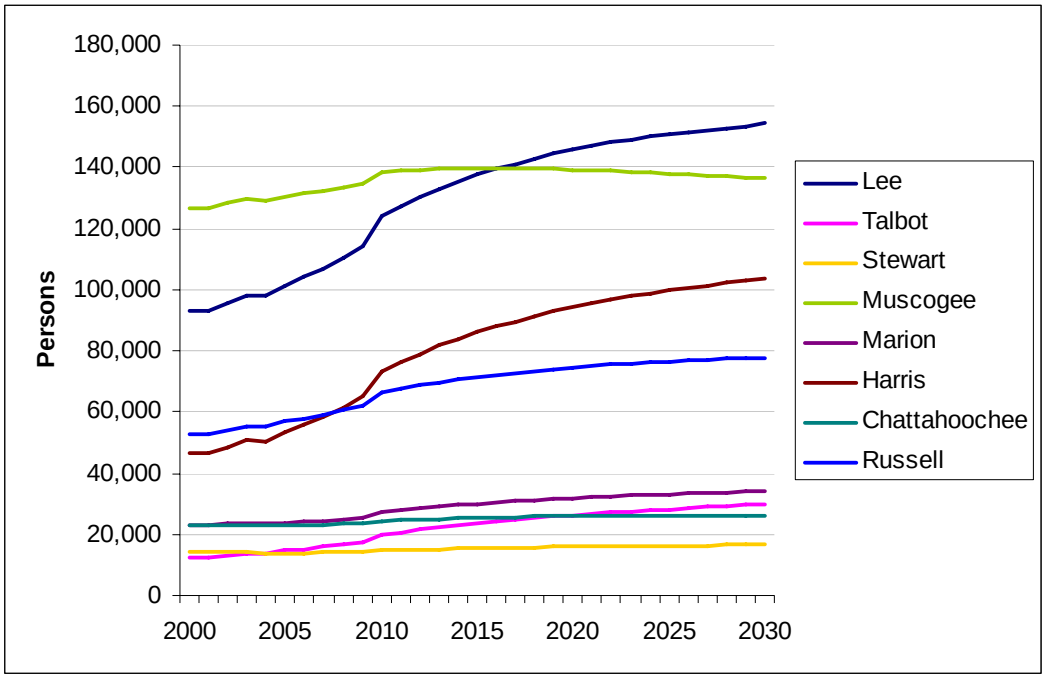


Figure 8. Fort Benning population change Army transformation scenario.

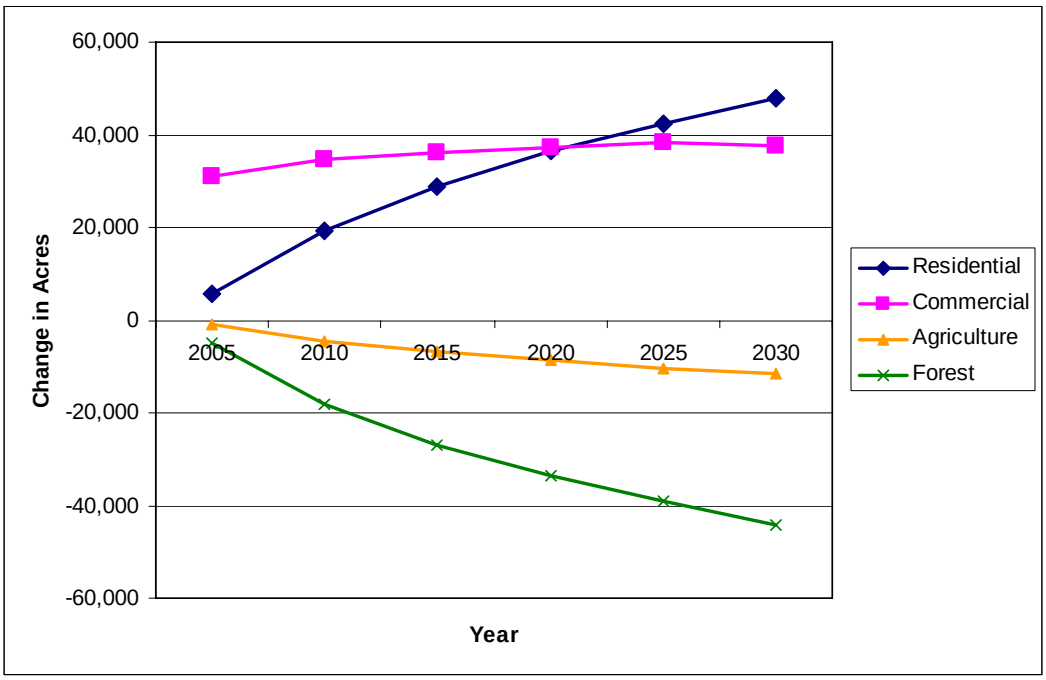


Figure 9. Fort Benning Army transformation land use transformations scenario.

Table 2. Fort Benning land use transformations.

Fort Benning Sub-Region				
	2000 Landcover (Acres)	2030 Business as Usual	2030 High Growth	2030 Increased Military
Residential	53,927	95,632	128,607	101,846
Commercial/Industrial	138,372	144,904	150,671	146,333
Agriculture	205,311	195,227	186,720	193,572
Forest	1,750,761	1,712,607	1,682,373	1,706,620

Bragg Sub-Region Land Use Change Maps

Business as Usual

Figure 10 contains maps depicting the simulated urban growth in the seven-county region surrounding Fort Bragg. The counties included in this model are: Lee, Harnett, Moore, Cumberland, Hoke, Richmond, and Scotland. The base growth rate of 25.6 percent, an annual average of 0.85 percent, is based on historical population changes in the region. In this scenario population in the region increases by about 173,000; residential development increases about 52,000 acres; and commercial development increases by 3,000 acres. The accompanying loss of agriculture land is 20,000 and nearly 35,000 acres of forest land is lost (Table 3).

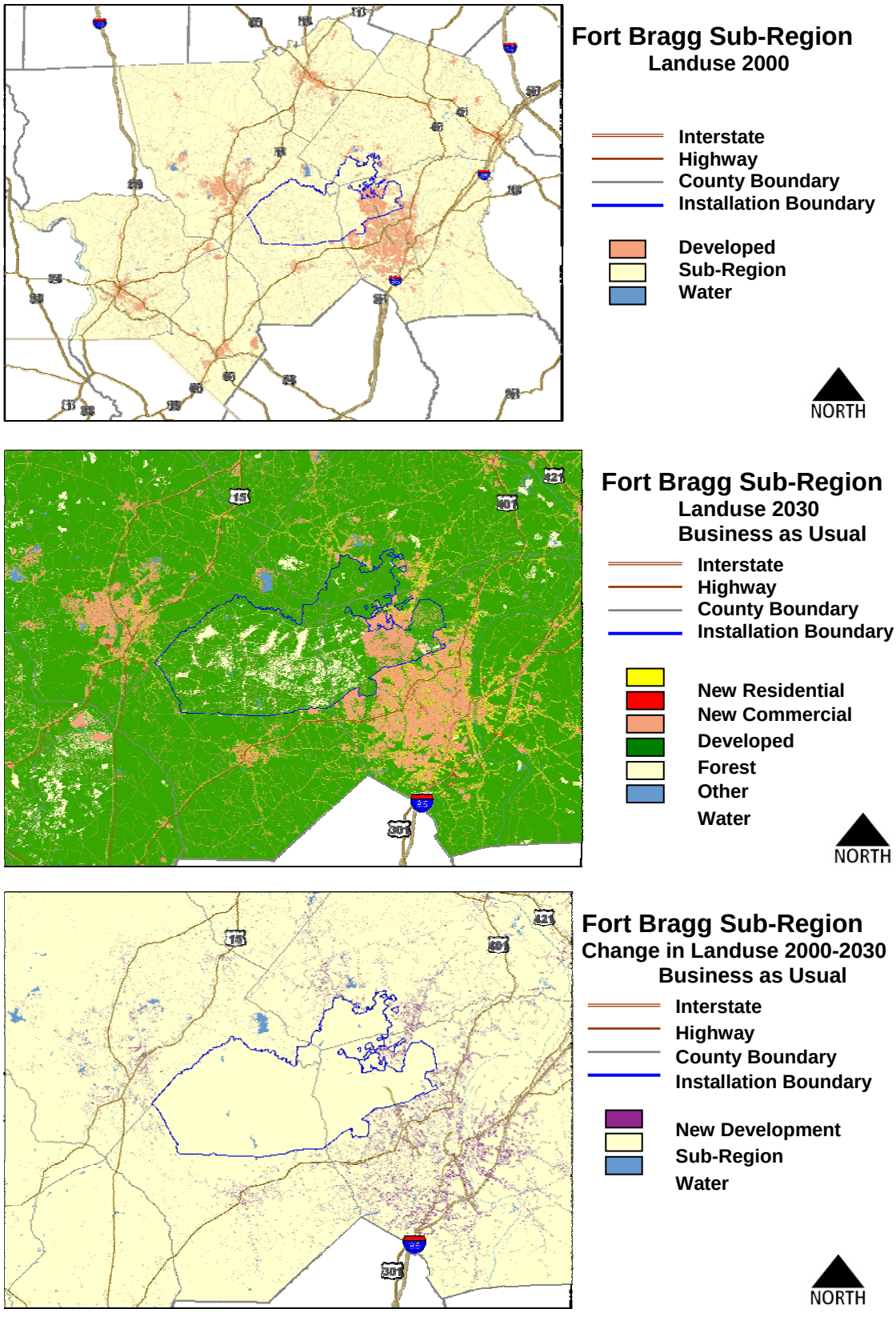


Figure 10. Fort Bragg Business as usual land use change scenario.

Table 3. Fort Bragg land use transformations.

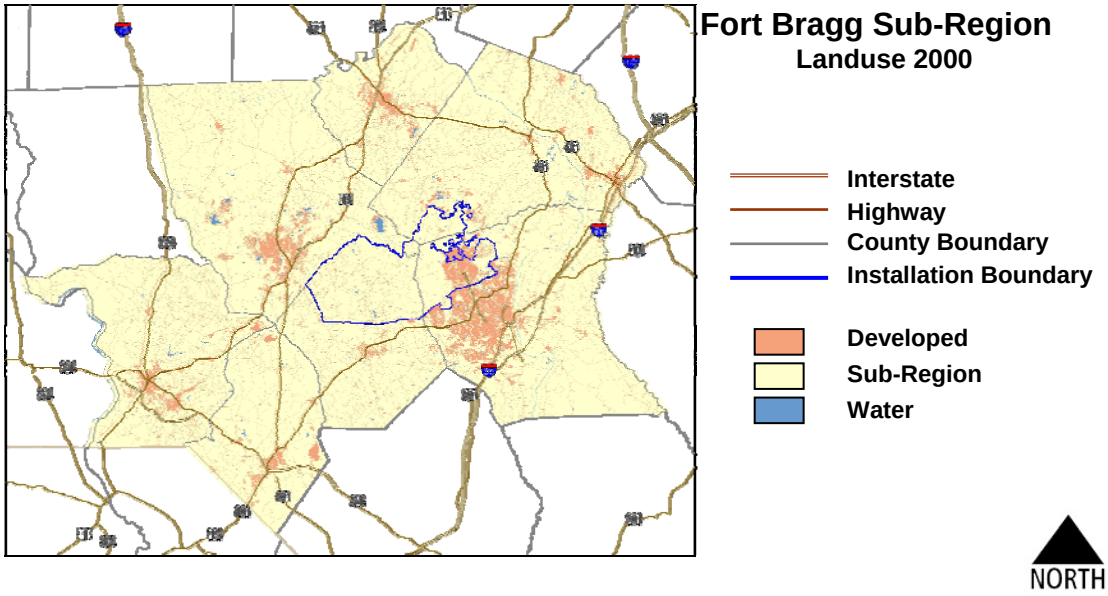
Fort Bragg Sub-Region			
	2000 Landcover (acres)	2030 Business as Usual	2030 High Growth
Residential	93,218	145,149	196,984
Commercial/Industrial	67,520	70,503	73,443
Agriculture	439,262	418,861	396,385
Forest	1,538,861	1,504,348	1,472,050

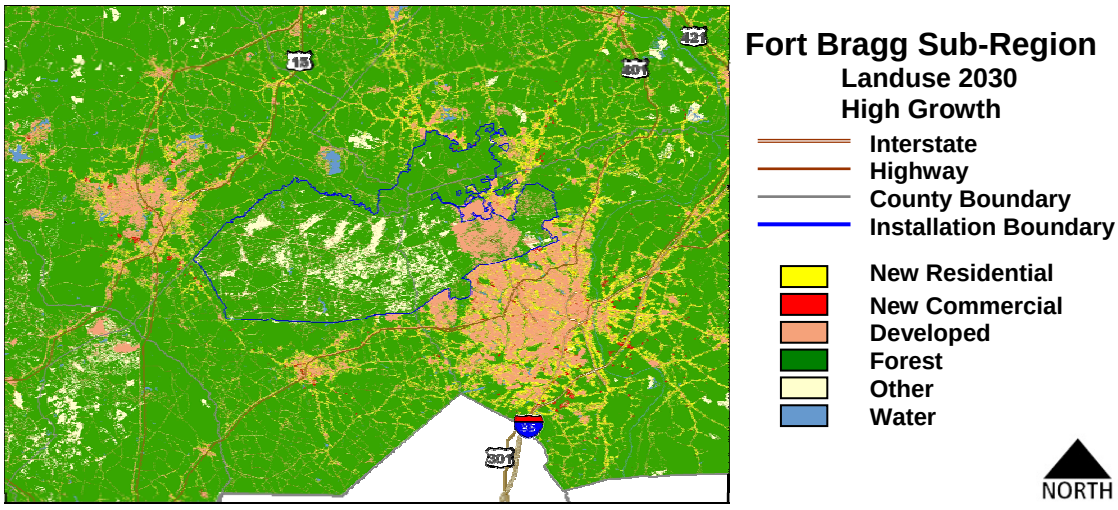
The land use change occurs predominantly to the south of Fort Bragg—growth is seen in and around the towns of Raeford and Silver City. To the west, growth occurs along Highway 15 and Business Route 1, the location of a string of small towns and urban areas. Growth to the east of Fort Bragg occurs primarily in the city of Fayetteville, but it also spreads north-east along Highways 95 and 401. Growth most likely occurs southward along Interstate 95, but the modeling did not include Robeson County. Appendix F details land use change by county for all growth scenarios.

High Growth

Figure 11 contains maps showing simulated urban growth in the region assuming a relatively high growth rate in the region's population. The model uses a population growth rate of 3 percent/year for a total increase of 89.5 percent. This results in a population increase of 499,000, an increase of 104,000 acres in residential land use, and an increase of commercial/industrial land use by 7,000 acres. This development comes at the expense of 43,000 acres of agricultural land and 67,000 acres of forest (Figures 12 and 13, and Table 3)

Land use change occurs in the same areas as in the base growth scenario.





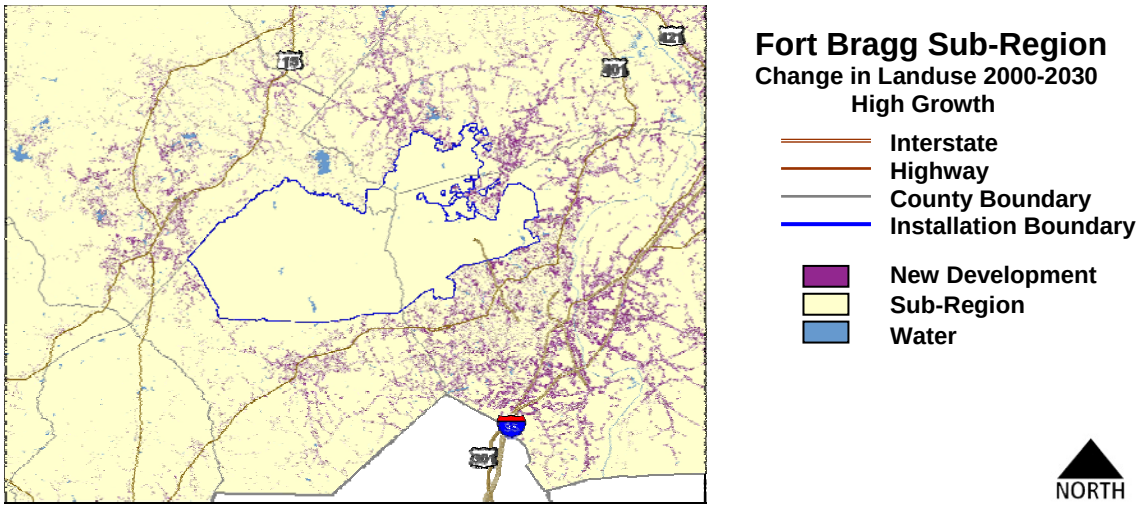


Figure 11. Fort Bragg high growth land use change scenario.

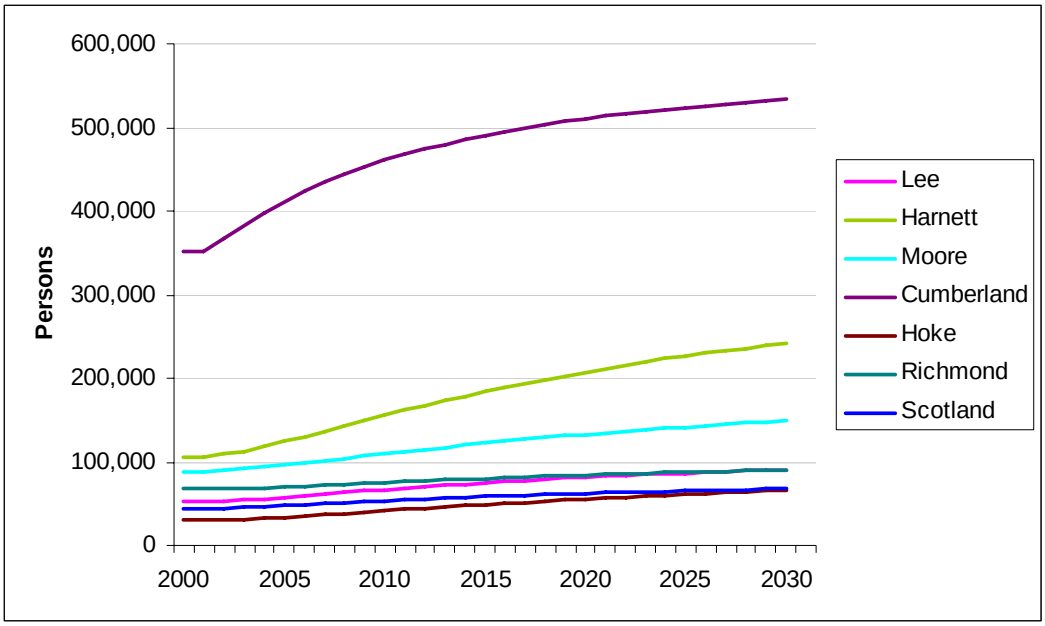


Figure 12. Fort Bragg population change high growth scenario.

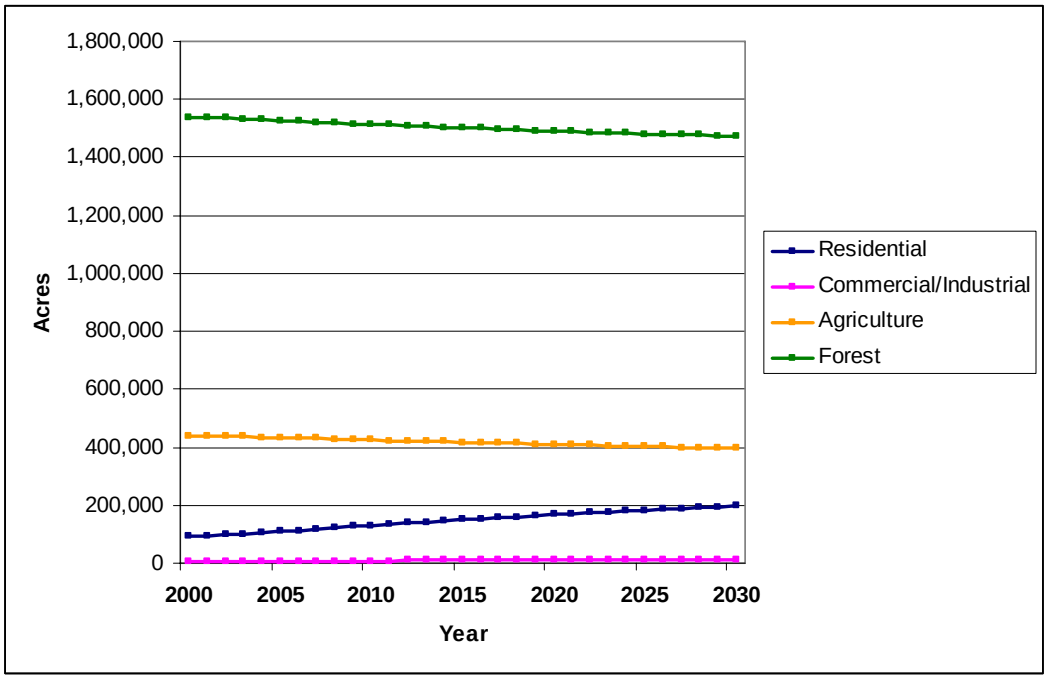


Figure 13. Fort Bragg high growth land use transformation scenario.

Jackson Sub-Region Land Use Change Maps

Business as Usual

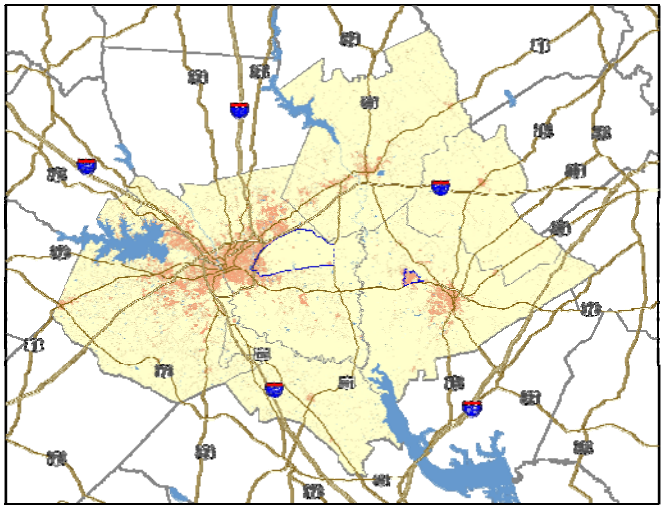
Figure 14 shows the simulated urban growth in the six-county region surrounding Fort Jackson. The counties included in this model are: Lee, Sumter, Richland, Lexington, Kershaw, and Calhoun. The Fort Jackson region experiences the greatest amount of population increase and accompanying land use change. The base growth rate of 28.3 percent, an annual average of 0.94 percent, is based on historical population changes in the region. In this scenario population increases by 357,000. Land use change increases the amount of residential land by 82,000 acres and commercial/industrial land by 7,000 acres. The accompanying loss of agriculture land is 36,000 and 51,000 acres of forest land is lost (Table 4).

The land use change in the Fort Jackson sub-region occurs in the Columbia metropolitan area, which is growing toward the post from the west and engulfing it on three sides.

High Growth

Figure 15 shows images that depict simulated urban growth in the region assuming a relatively high growth rate in the region's population. The model uses a population growth rate of 3.3 percent/year for a total increase of 99.1 percent. In this scenario population increases by 854,000. This results in an increase in residential land use of 163,000 acres while commercial/industrial increases by 14,000 acres. This development comes at the expense of 72,000 acres of agricultural land and 102,000 acres of forest (Figures 16 and 17, and Table 4).

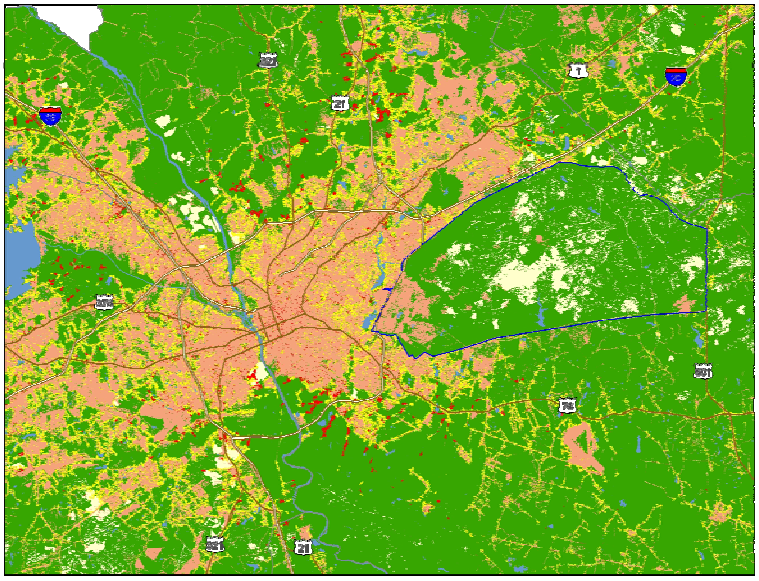
Land use change occurs in the same area as in the base growth scenario. Development to the north and south of the post is denser. Appendix F details land use change by county for all growth scenarios.



Fort Jackson Sub-Region
Landuse 2000

- Interstate
- Highway
- County Boundary
- Installation Boundary
- Developed
- Sub-Region
- Water

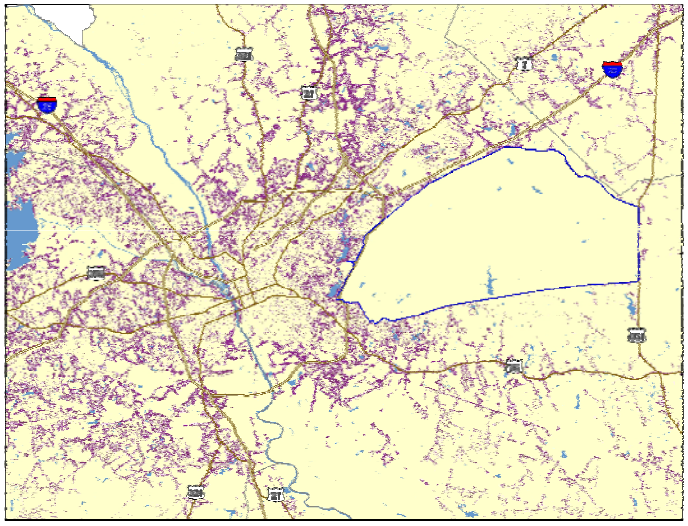
NORTH



Fort Jackson Sub-Region
Landuse 2030
Business as Usual

- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Residential
- New Commercial
- Developed
- Forest
- Other
- Water

NORTH



Fort Jackson Sub-Region
Change in Landuse 2000-2030
Business as Usual

- Interstate
- Highway
- County Boundary
- Installation Boundary
- New Development
- Sub-Region
- Water

NORTH

Figure 14. Fort Jackson business as usual land use change scenario.

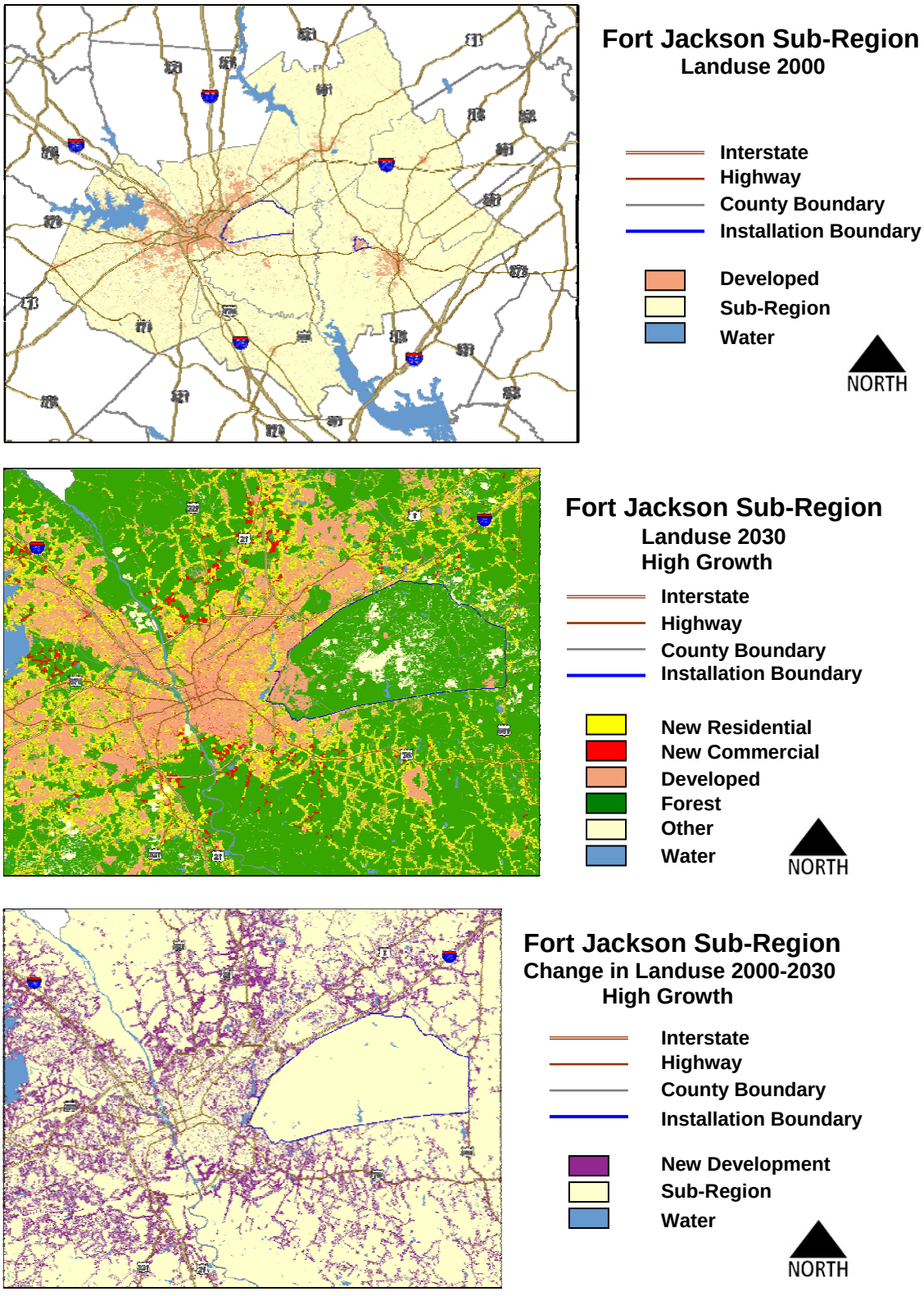


Figure 15. Fort Jackson high growth land use change scenario.

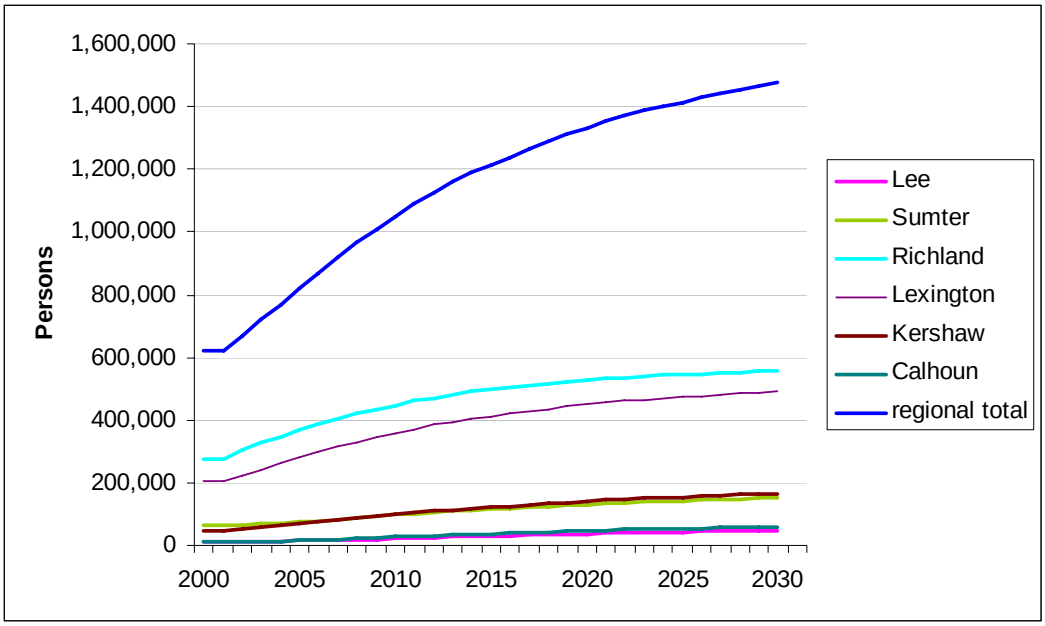


Figure 16. Fort Jackson population change high growth scenario.

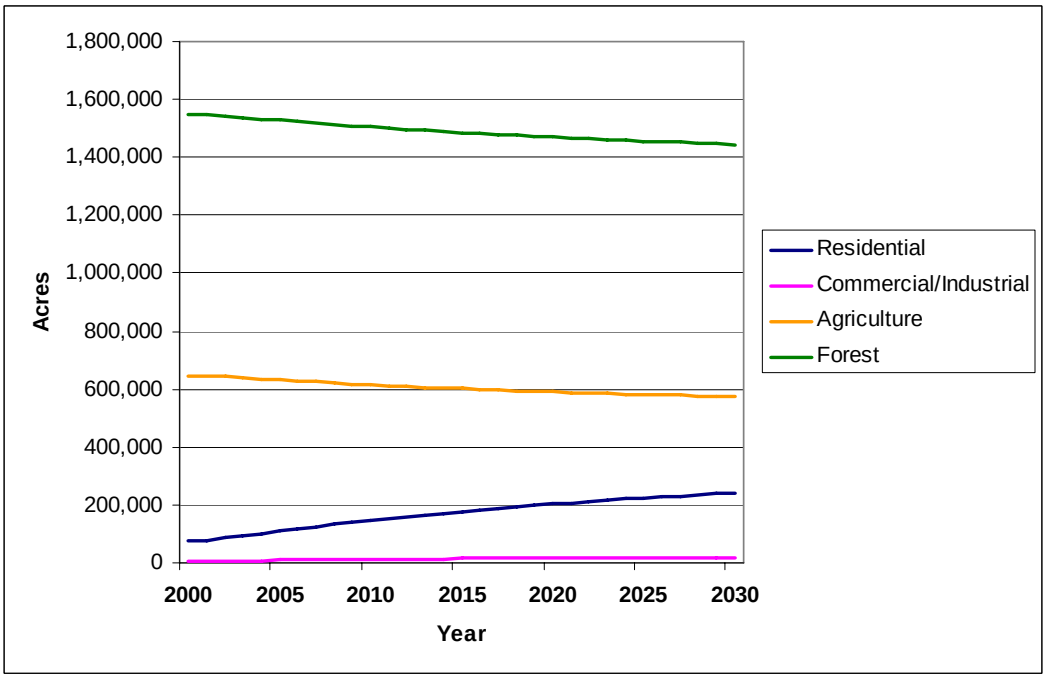


Figure 17. Fort Jackson high growth land use transformation scenario.

Table 4. Fort Jackson land use transformations.

Fort Jackson Sub-Region			
	2000 Landcover (acres)	2030 Business as Usual	2030 High Growth
Residential	79,108	160,919	242,630
Commercial/Industrial	59,299	64,831	70,066
Agriculture	645,190	609,218	572,839
Forest	1,546,133	1,494,763	1,444,196

6 Impact Analyses and Future Outcomes

Analyze Impacts

The question then is how changes in population, land use patterns, Army transformation, economics, climate, and energy sources impact one another as well as local sustainability objectives. LEAM™ projected land cover maps were input into three separate models to project the annual impacts on these issue areas.

Analyze Future Outcomes

Air Quality Outcomes

Air quality impacts were modeled using the Sustainability Module of the LEAM™ model. The module predicts the emission implications of the urban growth and land-use changes in the land cover maps generated by LEAM™. Energy usage data for residential and commercial buildings, by census region for both new construction and existing buildings was used to generate the amount and type of energy use projected (EIA 2001; EIA 2003). Air pollution factors for direct combustion energy usage were based on the USEPA factors from AP-42 (USEPA 2006) and emission factors for electrical power were from the Cleaner and Greener Environmental Program (Leonardo Academy 2004). Estimated vehicular usage and their emissions was based on EIA trends (EIA 2003). Air emissions vary from local to regional depending on the type of energy used. For instance, air emissions due to electrical consumption do not appear locally since the power plants are distant from the demand centers. Local results are based on direct usage from buildings, commercial activities, and automobiles, while regional impacts include power generation.

Appendix G provides the analysis of the air emissions modeling for the three areas of the Fall Line Region modeled. Air emissions are expected to grow in light of the significant regional growth expected in all areas. Residential and commercial building growth adds directly to the emissions in the areas.

Water Quality Outcomes

Water is a vital resource facing grave risks. Water tables are falling on every continent. Snow/ice reservoirs are shrinking. Rivers are failing to

make it to the sea. Conflicts are erupting over water rights. These trends are a prescription for severe environmental, social, and economic damage (SSA White Paper). Abundant research supports that water is a constraint on growth and development. Thus to meet the needs of the future, it is critical that water is and will continue to be available in sufficient quantities and quality.

The reasons for water resource damage range from a changing climate to increasing population and poor development patterns. Yet, how to sustain water supply is not what this report is about, although it is a subject of great importance. Here discussion focuses on how to characterize the state of current and future water quality. The effort is in formulating methodologies to characterize water quality within a region. Given this characterization, stakeholders may further develop how to mitigate negative impacts and evaluate what is necessary to maintain the purity of air, water, and the beauty of our landscape.

Because water is ubiquitous, there is a long list of possible quality indicators and modeling tools, all of which seem necessary. But, how many are really needed? Select too many, and the sustainability problem becomes impossible to comprehend and too costly to carry out. Select too few, and the picture of water resources will be too sketchy to be useful. One needs to find an appropriate balance. Numerous organizations focus on gathering physical, chemical, and other traditional water data. Appendix H provides a list of water data sources and their provided indicators. The USEPA and U.S. Geological Survey (USGS) are national leaders in gathering such data. They have reported area, flow, erosion, nutrient levels, toxins, withdrawal rates, etc. across the United States. Using this data, an array of models assesses water quality. Yet to evaluate water quality resources, one must study the whole ecosystem. An effective set of water indicators address elements of the entire water system and include ecological, social, and economic measurements (Smith, Zhang 2004). Ecological indicators measure the integrity of ecosystems. Categories of data include chemical compositions, temperature gradients, landscapes, habitats, and so forth. Social indicators measure the well-being of water. These include human-health issues, recreational opportunities, cultural beliefs, and technical capacities for management. Economic indicators measure human-use elements such as conservation practices, water cost and quality for use, recreational capabilities, water hazard protection, and the like.

A selection of ecological, social, and economic water indicators is the most successful approach to identifying impairment or degradation of water resources, developing water quality standards and criteria, responding to and guiding program goals, and providing a foundation of data for future needs. The most informative methodologies use multi-metrics. However, indicator selection is limited by financial, technical, and organizational resource constraints.

The remainder of this section examines how current regulations and practices are shaping water management and how they have and can be applied to the Fall Line Region. The objective is to highlight approaches to comprehensive, regional-scale assessments that effectively inform decision-makers as to the magnitude, extent, distribution, and uncertainty of current and anticipated water quality risks.

Current Trends in Management and Evaluation

In recent years, Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) rules concerning water quality, effluent standards, and drinking water standards have been revised at an exponential rate. These revisions are spurred by the desire to implement a watershed management approach.

Today, Total Maximum Daily Loads (TMDLs) are essentially driving the watershed approach to water quality management. Originally mandated in 1972 by Section 303(d) of the Clean Water Act (CWA), TMDLs came from the perspective that all point and nonpoint sources of pollution in a watershed are inextricably linked. However at that time, people had a more limited idea of what constituted pollution. They pictured a big pipe spewing waste into a river. Thus, TMDLs were not aggressively pursued until a series of lawsuits against the USEPA began in the late 1980s, compelling USEPA and state environmental agencies to focus on the TMDL provision of the CWA. Focus shifted from cleaning up pipe discharges to addressing both point and nonpoint source pollution on a watershed basis. Nonpoint source pollution involves a large and diverse group of agencies and individuals on urban, agricultural, range, and forested lands. It forces land and water managers to explore a realm of science that is little understood and often poorly quantified.

The USEPA requires states to submit a Section 303(d) list—a report of streams and water bodies that do not meet ambient water quality standards—every 2 years. The Section 303(d) list provides a basis for decisions

related to restoring water quality. Listing rivers under Section 303(d) is the responsibility of state and tribal environmental agencies. They must report their finding to the USEPA. Impaired water bodies on the 303(d) list are slated for TMDLs.

In a typical TMDL application, the beneficial uses of the water body are first established. These could include drinking water, recreation, aesthetics, irrigation, fishing, and swimming. The TMDL of pollutants are then set at a level that will allow the water body to achieve water quality standards for beneficial uses. Established pollutant loads are calculated in mass/unit time entering a water body, with typical units of pounds/day. Point and nonpoint sources of pollutants are then identified and mitigation actions are resultantly applied.

TMDLs typically demand a great deal of work, coordination, and financial investment. If there is one thing to make clear, it is that one entity cannot develop, implement, and monitor a TMDL alone. The amount of data required as well as the amount of modeling needed to quantify nonpoint sources are extensive. TMDLs are the result of several years of hard work.

In addition to the requirements laid out in the CWA and the SDWA, the *Unified Federal Policy of Ensuring a Watershed Approach to Federal Lands and Resource Management* along with numerous executive orders are directing DoD installations to apply a watershed protection approach to military activities and site management. The DoD wants to develop a watershed management tool kit to comply with the CWA; SDWA; Comprehensive Environmental Restoration, Cleanup, and Liability Act; Resource Conservation and Recovery Act; Superfund Amendments Reauthorization Act; P2; restoration; facility engineering; and conservation statuary/regulatory requirements.

The new emphasis is for DoD installations to evaluate the impacts their activities may have on the quality and quantity of water entering a watershed. As a result, the DoD pushed to develop their own watershed management strategy, and the DoD Clean Water Act Services Steering Committee developed the *DoD Watershed Impact Assessment Protocol: Installation Assessment and Planning Guidance*. The Protocol targets DoD installation activities having the potential to contribute pollutants to impaired waterbodies and/or drinking water sources on or near the installation. The Protocol calls for establishing baseline water quality, developing a watershed priority score for impaired waters, and an activity impact

score for activities causing impairments. The two scores are then added to establish a total activity burden score. By identifying preventive measures to reduce adverse effects of activities known to impair water quality; an installation can develop a solution to reduce the total activity burden score in the most cost-effective manner available. The objective is to provide DoD installation personnel with a holistic approach to assessing, prioritizing, and mitigating impacts of their activities on watersheds.

The Protocol clearly outlines a seven step process to establish a total activity burden score. Information required to complete the steps require a synthesis of a wide variety of complex environmental information specific to an installation. The general approach of the Protocol details activities taking place on the installation and associates typical potential impacts that activity has on water quality. It is a screening process to determine the severity of potential risks to the water quality. A number of models do the same thing, but are specified at the regional (not the installation) level.

Hundreds of additional water resource models address groundwater, surface water, aquatic habitat, and the combinations through the use of traditional water data sources. The USGS Surface-water quality and flow Modeling Interest Group (SMIG) has complied an archive of water resource models linked with the model technical reports and developers' contact information. This archive is available on the Internet through URL:

http://smig.usgs.gov/SMIG/model_archives.html

The USEPA Regional Vulnerability Assessment (ReVA) program has compiled a similar archive. (Appendix H summarizes both archives.) The ReVA archive is available on the Internet through URL:

http://amethyst.epa.gov/revatoolkit/Welcome.jsp

Given the abundance of available models, three model types have been prioritized for a regional water quality analysis—run-off, chemical concentration, and impervious surface. Appendix H provides a discussion of each modeling type. Overall, run-off models estimate peak run-off at any location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall. Run-off models are simplistic, transferable, and provide accurate estimates of water quality and quantity. Chemical concentration models predict the conditions likely to impact water quality and use statistical regressions to estimate future pollutant concentrations. Impervious surface models relate the percentage of impervious surface to changes in the natural patterns of water movement. The results focus on urbanization's impact on river flows and recharge of groundwater.

Models Used in the Fall Line Region

Unfortunately, water resource analysis efforts already completed in the Fall Line Region are limited to a TMDL analysis conducted for the Georgia Chattahoochee River watershed and a suggestion that the USEPA's ReVA program conduct an analysis for USEPA region IV. ReVA is an approach to regional-scale ecological risk assessment that is currently under development by USEPA's Office of Research and Development. The pilot assessment was completed for the mid-Atlantic region and builds on data collected for the Environmental Monitoring and Assessment Program (EMAP) and other monitoring efforts. ReVA is being developed to identify those ecosystems most vulnerable to being lost or degraded in the next 5 to 25 years and to determine which stressors cause the greatest risk to ecosystem goods and services. Since completion of the pilot study in 2003, the ReVA program has expressed interest in beginning work in USEPA region IV, which includes the Fall Line Region. However, no work has begun.

Despite this, DoD installations within the region are committed to sustainable practices as it relates to the use and discharge of water resources. (Appendix J, "Water Gap Analysis" describes installation specific efforts and conditions.) For example, Fort Bragg has recently implemented a water conservation policy and both Fort Bragg and Fort Benning have included water use and discharge goals in a long-term sustainability plan. Furthermore, the SERDP Ecosystem Management Project (SEMP) has encompassed two water monitoring programs at Fort Benning (Graves 2001; Kress, 2001).

Modeling the Fall Line Region

The prime directive is to provide a generalized picture of future water quality within the Fall Line Region given forecasted regional conditions. Run-off and impervious surface assessments are generally agreed on as relatively accurate water quality generalizations. The models selected for this evaluation are the Long-Term Hydrologic Impact Assessment (L-THIA) to estimate regional run-off and a simplified version of NOAA's Impervious Surface Analysis Tool (ISAT) to estimated regional imperviousness. (Appendix H further describes these models.) Both forms of assessment used the land use prediction maps from LEAM™ model outputs. Thus, water quality could only be modeled for those sub-regions selected for LEAM™ modeling and having the proper output format. These were Fort Bragg and Fort Jackson. Yet, as previously mentioned, these sub-regions are the areas where the greatest amount of change is expected and

therefore exemplify regional trends and illustrate where mitigation strategies would have the greatest ameliorative effect.

L-THIA Model Results

The following information was used to analyze the effects of land use changes using L-THIA:

- 2000-2030 land use maps at 5-year increments for the Fort Bragg region from LEAM™ using a 25.6 percent growth rate
- 1975-2004 regional precipitation data from the National Oceanic and Atmospheric Administration (NOAA)
- Hydrologic soil group map for the Fort Bragg region from USGS.

Table 5 provides total run-off and landcover statistics for the Fort Bragg Region from 2000 to 2030. The changes in run-off can be attributed to the changes in landcover. Over 30 years, a 1,731 acre increase of residential landuse results in over 8.5 billion liter increase in run-off. This is the largest increase in runoff caused by one land use change for the Fort Bragg Region. Expansion of residential and/or commercial land uses—which typically produce high levels of run-off—into an area that was originally wetland/forest/grassland—an area producing little runoff—significantly changes hydrology of a region. Had a landuse with a significantly higher runoff than a wetland, such as industrial, or agricultural been changed to residential, the increase in runoff would not be as significant.

The overall runoff of the entire region changes by nearly 1.4 billion liters, which is only 0.01 percent of the total run-off. This slight increase of run-off is due to the fact that some land uses that cause higher runoffs have been changed to landuses causing lower runoffs, large areas under agriculture use change to commercial for example. Such changes can be used to offset the effect of increased runoffs due to increase in residential uses.

Although the increase in runoff in this example may appear negligible, it is important to consider the consequences of the 54,914 acres of rural land being converted to urban landuses. Changes of landuses can have several other impacts on adjacent areas such as increased rate of sedimentation that may rapidly destruct habitat for plants and animal species, loss of groundwater recharge, increased flooding, and increased pollutant loading on water sources.

Table 5. Fort Bragg regional run-off vs. landcover.

	2000	2005	2010	2015	2020	2025	2030
ANNUAL RUN-OFF (liters)							
Residential	1,976,520,977,557	1,985,087,017,283	1,993,653,057,009	2,002,219,096,735	2,010,785,136,461	2,019,351,176,187	2,027,917,215,913
Commercial	73,350,121,676	73,997,186,092	74,644,250,508	75,291,314,924	75,938,379,340	76,585,443,755	77,232,508,171
Agricultural	2,594,092,063,266	2,590,812,987,376	2,587,533,911,485	2,584,254,835,595	2,580,975,759,704	2,577,696,683,814	2,574,417,607,924
Forest	10,260,151,514,073	10,254,456,751,688	10,248,761,989,303	10,243,067,226,918	10,237,372,464,533	10,231,677,702,149	10,225,982,939,764
Total Run-off	14,904,114,676,573	14,904,353,942,439	14,904,593,208,305	14,904,832,474,172	14,905,071,740,038	14,905,311,005,905	14,905,550,271,771
LANDCOVER (acres)							
Residential	93,218	101,391	112,088	121,458	130,100	137,862	145,149
Commercial	67,520	68,000	68,615	69,157	69,654	70,097	70,503
Agriculture	439,262	436,554	432,502	428,719	425,151	421,897	418,861
Forest	1,538,861	1,532,917	1,525,656	1,519,528	1,513,958	1,509,006	1,504,348
Total Acres	2,138,862	2,138,862	2,138,862	2,138,862	2,138,862	2,138,862	2,138,862

Source: L-THIA, 2005; LEAM™, 2005

Estimates of pollutant loads during 2000 to 2030 indicate increases in total suspended particulates and total phosphorus, while total nitrates decrease. These trends (shown in Figure 18) further illustrate how urbanization can deteriorate regional agricultural and forested lands. Although the Fort Bragg Region has no set goals to address the amount of contaminants in surface water run-off, the entire Region must meet or exceed North Carolina state high quality water (HQW) standards. Increasing pollutants in surface water run-off will likely degrade current water qualities and increase regulatory and public scrutiny of the North Carolina Department of Environmental and Natural Resources (NCDENR). Contamination of regional water resources, particularly by sediments, is a critical consideration in North Carolina due to the economic impacts associated with destruction of fish habitats, costs of water treatment, and the decrease of reservoir holding capacity. An adequate supply of clean water is an increasing concern in the State and has become a priority for the NCDENR. Pollutant loads from agricultural lands and point source nutrient loads from urban/suburban lands can decline with management actions.

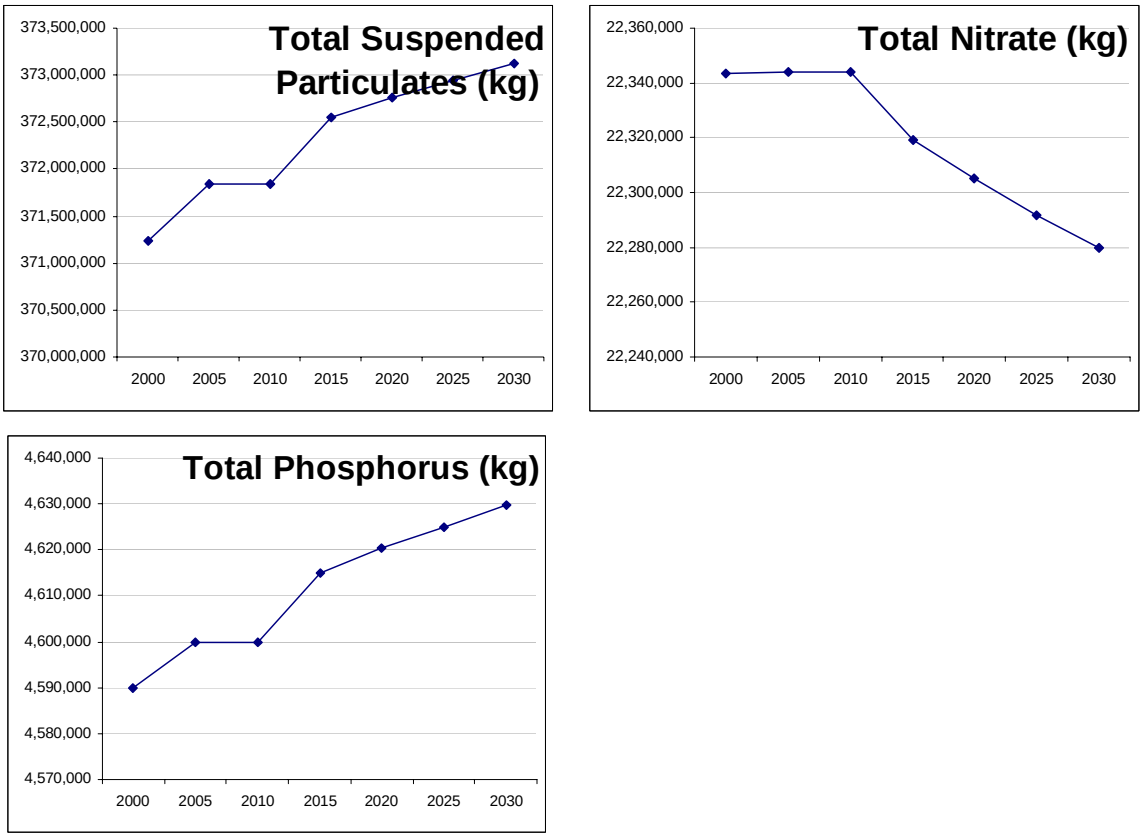


Figure 18. Fort Bragg regional nutrients/pollutant comparison.

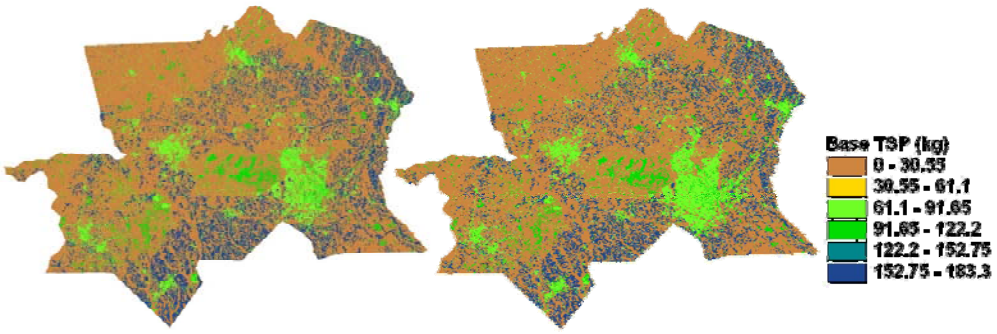


Figure 19. Fort Bragg regional total suspended particulates, 2000-2030: "Business as Usual" (2000); "Business as Usual" (2030).

Figure 19 shows that increases of run-off pollutants—specifically total suspended particulates—are primarily generated from urban areas. Therefore, overall increasing population trends will most likely lead to soil disturbance that degrades regional water quality unless land use conversions are properly managed.

It has been suggested that run-off is increasing within the Fort Bragg Region due to land use decisions that do not consider the effects of development on a watershed. Particularly troubling is that this damage tends to be inequitable, affecting those who likely have no immediate control. Homeowners, farmers, and communities downstream from new developments may face increased potential for flooding as well as sedimentation and reduced water quality through soil erosion and runoff of nonpoint fertilizer and pesticide pollution. Wildlife may face depleted or destroyed habitats through erosion and destruction of riparian areas. Finally, the general public is affected by the destruction of environmental amenities both psychologically and through a potential drop in water quality and quantity as aquifers near the surface may not be replenished due to high rates of run-off (USEPA 1997).

L-THIA Climate Change Scenario Results

The L-THIA analysis was also carried out using a hypothetical climate change scenario. This process helps illustrate the type of results produced by this method and demonstrates how the impacts of present and proposed actions on the amount of runoff generated by different land uses can be easily estimated. The scenario assumes normal rainfall from 2000 to 2009; two times normal rainfall amounts in 2010 through 2014; 11.6 percent decrease from normal rainfall in 2015; 23.3 percent decrease from

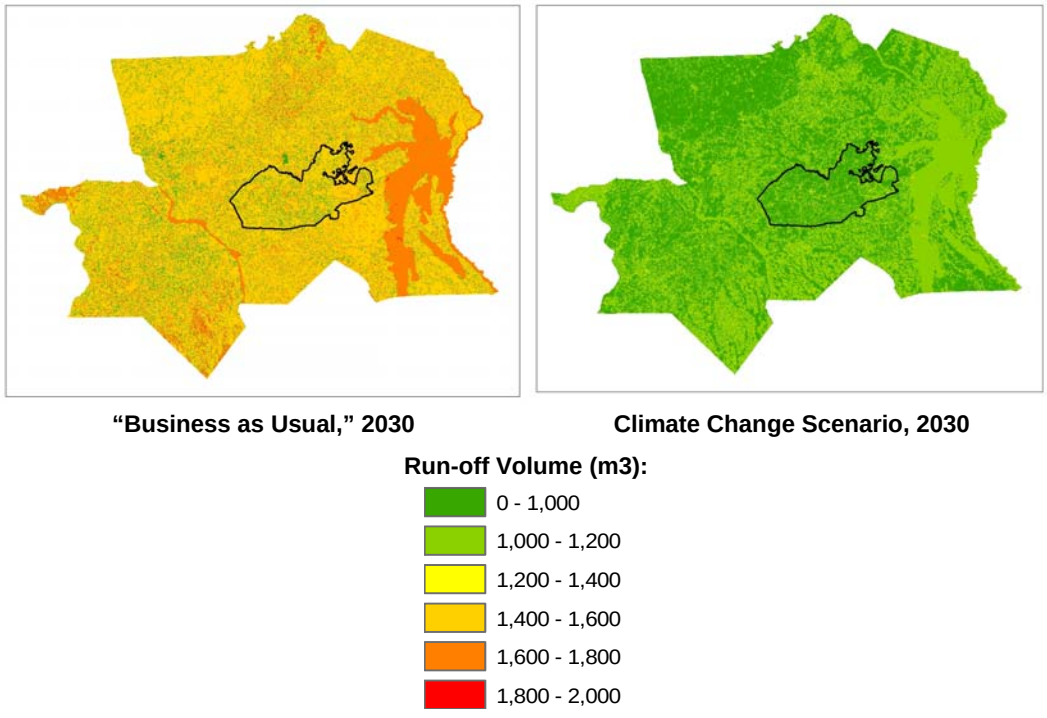
normal rainfall in 2016; and 35 percent decrease from normal rainfall in 2017 through 2030. No changes are made to land use patterns. Table 6 and Figure 20 present the results of L-THIA climate change scenario.

A comparison can be made of the total change in runoff caused by the changing climate. This is important in assessing the long-term hydrologic impact of changing environments. Natural patterns as well as urbanization can significantly impact the environment in terms of groundwater recharge, water pollution, and storm water drainage. However, because each land use has a different level of impact, careful physical planning can minimize these impacts. To be able to assess the best location for particular land uses such that changes (natural or human) have a minimum impact in terms of runoff is the next step in the application of the L-THIA model.

Table 6. Climate change scenario run-off annual variation.

	2000	2005	2010	2015	2020	2025	2030
ANNUAL RUN-OFF (liters)							
Residential	1,976,520,977,557	1,985,087,017,283	1,993,653,057,009	2,006,502,116,598	1,672,085,822,208	1,003,253,233,428	4,350,258
Commercial	73,350,121,676	73,997,186,092	74,644,250,508	75,614,847,132	63,013,300,154	37,810,206,199	5,565,267
Agricultural	2,594,092,063,266	2,590,812,987,376	2,587,533,911,485	2,582,615,297,650	2,152,180,153,886	1,291,309,866,359	4,435,069
Forest	10,260,151,514,073	10,254,456,751,688	10,248,761,989,303	10,240,219,845,726	8,533,517,912,448	5,120,114,045,893	8,246,059
Total Run-off	14,904,114,676,573	14,904,353,942,439	14,904,593,208,305	14,904,952,107,105	12,420,797,188,696	7,452,487,351,879	22,596,653

(Source: L-THIA 2005)



(Source: L-THIA 2005)

Figure 20. Scenario Run-off comparison, 2030.

Under severe drought conditions—gradual decreases in rainfall up to 35 percent over 15 years—surface water run-off would potentially decrease by over 14.9 trillion liters (nearly 100 percent decrease). On the other hand, a 200 percent increase in rainfall over 4 years, results in a mere 0.64 percent increase in runoff. The natural sandy soils, vegetation, and topography of the Fall Line Region help to control run-off production. The natural landscape is the best protector of water quality by absorbing run-off and keeping pollutants from reaching surface waters. Notice from Figure 20 that during a drought, rural landuses will absorb a majority of the water, while urbanized landuses continue to allow significant portions to run off. However because lower rainfalls could result in no run-off within rural areas of the study area, water availability may be severely compromised under drought conditions. The next step is to construct a hydrograph for regional basins and to determine peak flows. Although there may be little run-off to carry pollutants to streams, there will also be a lack of water to replenish streams and water reservoirs. To account for the effects of a drought, management actions are needed to address run-off amounts from particular landuses.

Impervious Surface Estimation Results

Impervious surfaces are widely recognized as a reliable indicator of the impacts of development on water resources. Impervious surfaces like asphalt, cement, and roofing prevent infiltration of rainfall into the soil, disrupting the water cycle and affecting both the quantity and quality of our water resources. The point is, those interested in preventing and/or mitigating the impacts of urbanization on water resources need to be aware of impervious surfaces—their relationship to the water cycle, their impacts on waterways, and the ways that this relationship can be used to inform better community planning and site design. This analysis provides an estimate of impervious surface area within the Fort Bragg and Fort Jackson regions using LEAM™ predicted land uses (2000-2030). The information can be used to identify sub-watersheds at highest risk for water quality impairment caused by excessive storm water runoff. The techniques used to perform this analysis were adopted from the NOAA ISAT program. ISAT derived impervious coefficients for land uses based on Connecticut state data. Although this may not as accurately apply to other regions—such as the Fall Line Region, these coefficients were used for example purposes. (Appendix H, Table H3 gives land use impervious coefficients.)

In essence, land use acres were multiplied by a corresponding coefficient, the multiplications were summed, and then divided by total acres. For ex-

ample, residential land uses are expected to have 59.9 percent imperviousness while evergreen forest land uses are expected to have 3.9 percent imperviousness. These percentages become the coefficients. Five acres of residential multiplied by 59.9 plus 5 acres of forest multiplied by 3.9 equals 319. Division of 319 by 10 total acres results in an estimated 31.9 percent impervious surface area.

Impervious surface programs (ISAT included) often use differing coefficients for high, medium, and low density areas. In other words, the land use map is overlayed with a density map and coefficients are derived from that. Such additions to modeling are recommended. However, this analysis is intended to provide a quick estimation of imperviousness for the study region as well as serve as an example of the type of analysis that can be performed. The intention is not to exactly measure imperviousness, but rather to illustrate an overall imperviousness trend.

As previously mentioned, NOAA defines less than 10 percent imperviousness as "protecting water resources," 10 to 25 percent imperviousness as "degrading water resources," and greater than 25 percent imperviousness as "impacted water resources." Figure 21 shows that both Fort Bragg and Fort Jackson's study regions will most likely remain within the 10 to 25 percent range over the next 30 years.

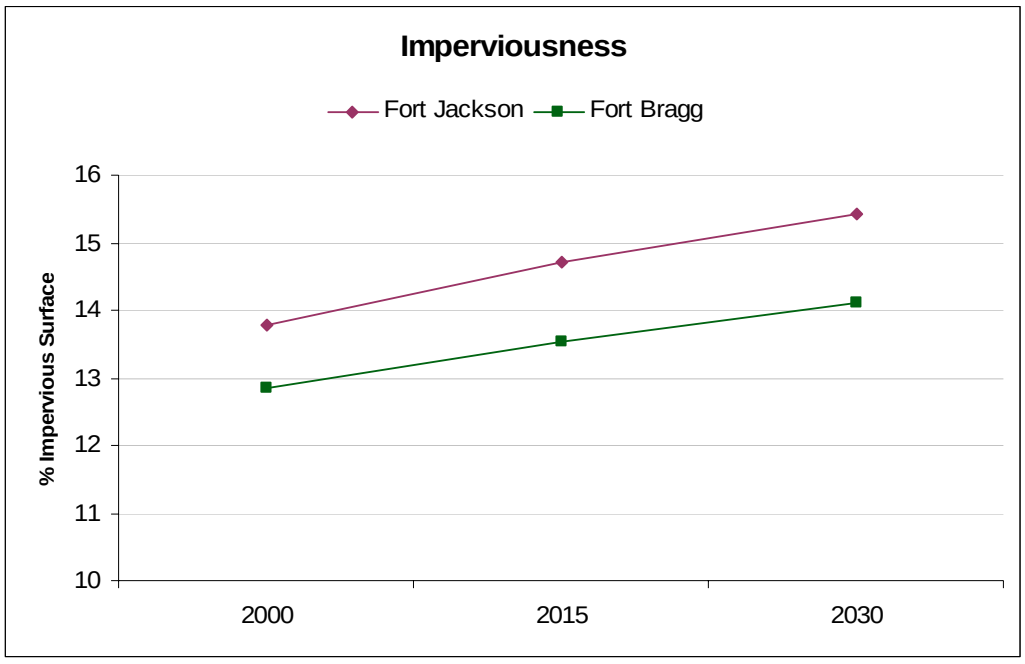


Figure 21. Imperviousness of Fort Bragg and Fort Jackson sub-regions.

Using current growth rates within each study region, imperviousness is expected to increases from 1.3 percent in the Fort Bragg region and 1.6 percent in the Fort Jackson region. Although each may appear to be negligible and neither increases cross the threshold into "impacted water resources," these increases are the result of 55,607 and 77,414 acres of rural land converting to urban land for Fort Bragg and Fort Jackson respectively. Within the Fort Bragg region, it is projected that over 34,000 acres of forest and 19,000 acres of row crops will be destroyed. The consequences of losing forested land includes not only impacts on water quality due to increased runoff and loss of groundwater recharge, but also the loss of habitat for plant and animal species. Endangered species such as the red-cockaded woodpecker rely on the forested lands within the Fort Bragg region for survival.

Within the Fort Jackson region, it is projected that over 50,000 acres of forest, 22,000 acres of row crops, and 1,000 acres of natural vegetation will be lost to residential and commercial uses. Expansion of commercial and residential land uses into areas that were originally forest and agricultural lands has a significant impact on the natural dynamics of the region. These are highly pervious surfaces changing to highly impervious surfaces. Had less pervious land uses than forest been overtaken with residential and commercial land uses, the conversion of 77,414 acres would not be as significant. And again, the loss of forest and agricultural lands not only impacts water resources, but also alters habitat for plant and animal species and economic resources.

Appendix H, Tables H4 and H5 list details on land use change and imperviousness at Fort Bragg and Fort Jackson. For visual purposes, Figure 22 below illustrates imperviousness per land cover polygon for Fort Bragg and Fort Jackson using 89.5 percent and 99.1 percent growth rates respectively. "Green" represents protected water resources (<10 percent imperviousness), "Yellow" represents degraded water resources (10-25 percent imperviousness), and "Red" represents impacted water resources (>25 percent imperviousness). Appendix H, Figures H-1 and H-2 show additional maps at 5-year increments (2000, 2005, 2010, 2015, 2020, 2025, and 2030) as well as depictions using 25.6 percent and 28.3 percent growth rates.

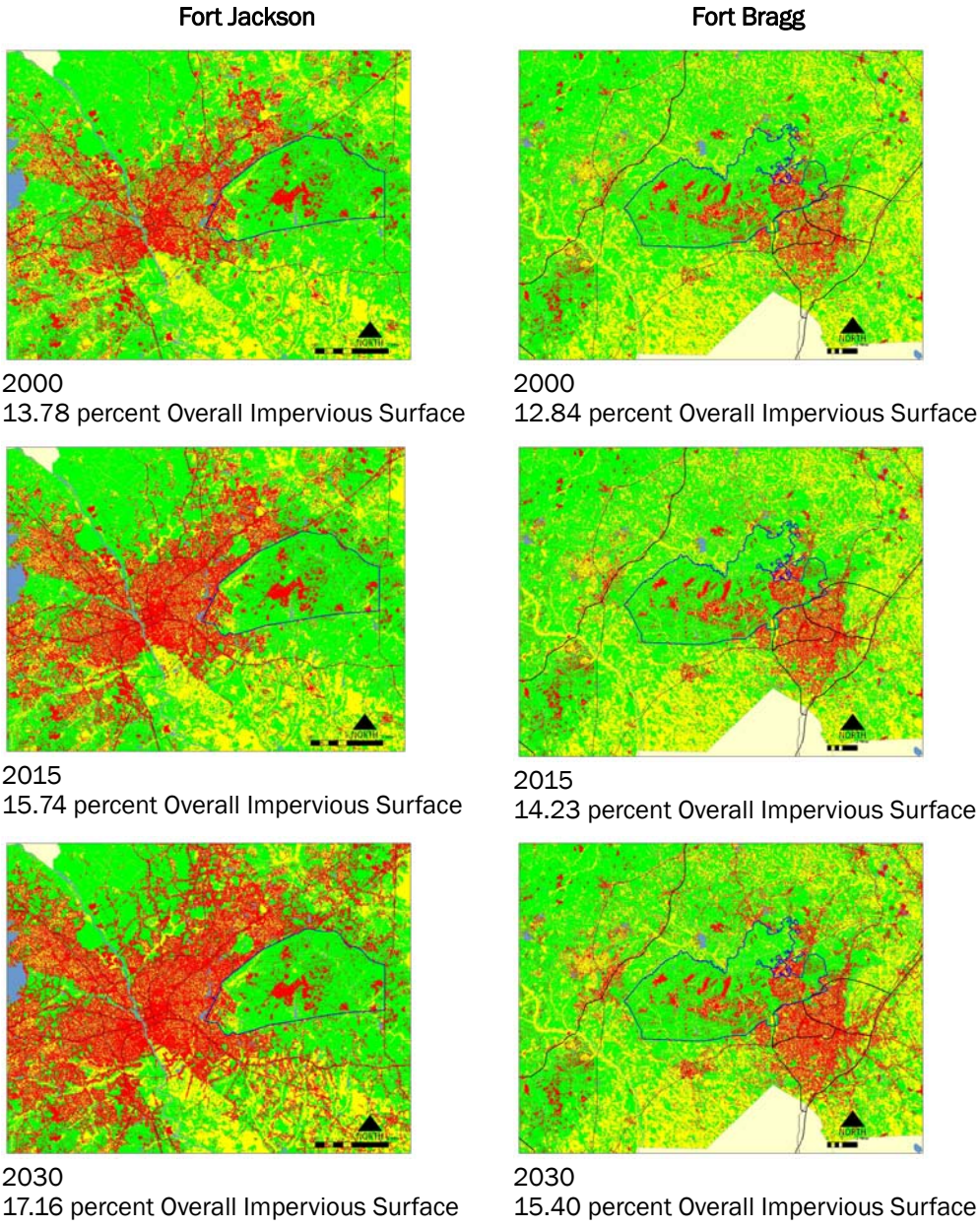


Figure 22. Impervious surface per landcover.

Future Water Resources

Predicted land use changes for regions within the Fall Line Region will lead to increased impervious area, greater amounts of runoff, and accelerating problems related to water quality and quantity. The results indicate that the future land uses reflected in the modeling will cause increased

surface water runoff. These increases are primarily due to the conversion of forest and agriculture into residential and commercial uses, and can be minimized depending on management practices.

Biodiversity Outcomes

The future of threatened and endangered species (TES) in this region becomes significant because of the broader context of the Southeastern United States. Because of relatively low soil fertility in this Fall Line Region, pressure for more intense agriculture land use and for urban expansion will likely occur in more fertile areas further coastward on the coastal plain. For this reason, it would be easier and less expensive for conservationists to target the Fall Line Region to help achieve some important national and regional conservation goals. An example of such a goal would be preserving and enhancing protected species habitats. As a significant land holder in the region, the DoD needs to anticipate and help shape future land use pressures—to ensure that defense mission requirements continue to be met while conservation goals are pursued.

Section 7 of the Endangered Species Act (ESA) passed in 1973 requires that all Federal agencies conserve TES, and in consultation with the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS), ensure their actions are not likely to jeopardize the continued existence of any TES or result in the destruction or adverse modification of critical habitat. Thus, the presence of TES on or near military lands endangers mission activities.

Identifying Critical Habitat of Biodiversity within the Fall Line Region

In assessing future habitat conditions, all Federally listed threatened and endangered species located within the Fall Line Region were considered. However, final selection settled on the gopher tortoise (Gopherus polyphemus) due to its critical status within the Fall Line Region. Further research on the ecology of the gopher tortoise and its habitat is needed to ensure that this species and other unique components of uplands in the Southeastern United States are preserved for the future. Loss of gopher tortoise habitat will only be a growing problem in the future. It is in the best interest of everyone to work together now to maintain habitat and revise forest management practices. Otherwise, the military will undoubtedly face significant encroachment on mission activities.

Moreover, many animals use gopher tortoise burrows for shelter and some burrow associates live most or all of their lives in the burrows. If gopher tortoises disappear, what will happen to these animals? Will the gopher frog, Florida mouse, gopher cricket, and other animals disappear along with the tortoise? Many researchers fear that if this "keystone" species becomes extinct, many other species will soon follow. Hence, the gopher tortoise habitat is a useful proxy for analyzing the impacts of land use change on biodiversity.

Studies within the Fall Line Region predominantly focus on identify the geographic distribution, habitat requirements, and trends in population of the gopher tortoise more than any other regional species. This extensive monitoring stresses the severity of the species' declining population. However, it is believed that changing forest management practices can reverse the declining viability of the gopher tortoise population and its critical habitat.

Characteristics of the Gopher Tortoise

Gopher tortoises live in extensive subterranean burrows in dry upland habitats of the coastal plain of the southeastern United States. The habitats where gopher tortoises are found include longleaf pine, Sandhills, xeric oak hammocks, scrub, pine flatwoods, dry prairies, and coastal dunes. Tortoises can also live in man-made environments, such as pastures, old fields, and grassy roadsides. To be suitable for gopher tortoises, the habitat must have well-drained sandy soils for digging burrows, herbaceous food plants, and open sunny areas for nesting and basking. Periodic natural fires play an important role in maintaining tortoise habitat by opening up the canopy and promoting growth of herbaceous food plants. If natural fires are suppressed, habitats may become unsuitable for tortoises. Today, land managers use prescribed fire to maintain tortoise habitat.

Gopher tortoises are afforded different levels of legal protection throughout their range. A permit is always required to possess, study, or relocate gopher tortoises. In the 1980s, Florida outlawed the harvest of tortoises, banned the use of gasoline to collect rattlesnakes from gopher tortoise burrows, and banned tortoise races. Table 7 lists the legal status of the gopher tortoise in states where it occurs and on installations in the Fall Line.

Table 7. Legal status of the gopher tortoise.

State	Status
Georgia:	State listed as a Threatened Species
Florida:	State listed as a Species of Special Concern
South Carolina:	State listed as an Endangered Species
Mississippi:	Federally listed as a Threatened Species
Alabama:	Protected non-game species; populations west of the Tombigbee and Mobile Rivers are Federally listed as a Threatened species
Louisiana:	Federally listed as a Threatened Species
Fort Gordon:	Documented onsite—abundant; suitable habitat was surveyed for the species from 1990 to 1992. Several young tortoises were observed, indicating recent active reproduction. Active and inactive burrows distributed in suitable habitat throughout the installation. Tortoise burrows occur within many training areas and artillery impact areas.
Fort Benning:	Documented onsite.

U.S. Endangered Species Act (ESA) enacted in 1973 is the nation's broadest and most powerful law for providing protection of endangered species and their habitats. A key aspect of the act's implementation is the need to determine the status of plants and animals at risk of extinction and compile a list of species in need of Federal protection. The ESA recognized two principal status categories, "endangered" and "threatened." As defined in the act, endangered refers to species that are "in danger of extinction within the foreseeable future throughout all or a significant portion of its range," while threatened refers to "those animals and plants likely to become endangered within the foreseeable future throughout all or a significant portion of their ranges." As a part of the listing process, two additional categories exist, "candidate" and "proposed" species. Candidate species are those for which the implementing agency, either the USFWS or the NMFS, has sufficient information about vulnerability and threats to support listing. Proposed species are those for which listing rules have been published in the Federal Register, but formal listing still awaits administrative action. Criteria in assessing conservation status include: occurrence, condition, population size, area of occupancy, range, trends, threats, fragility, and protected occurrences. The U.S. Fish and Wildlife Service and National Marine Fisheries Service are the two agencies responsible for implementing the act.

Mapping and Monitoring the Gopher Tortoise

Effective conservation requires the knowledge of existing resources, where they are found, and in what condition. The identity and geographical dis-

tribution of species becomes among the most important information needed for preservation efforts to succeed. State agencies across the country together with The Nature Conservancy (TNC) have worked for a quarter of a century to create a nationwide biological inventory effort known as the Natural Heritage Network. The fundamental mission of the heritage network is to help conserve the nation's dwindling biological resources by gathering, organizing, and distributing reliable biodiversity information. Ready access to such information is key to improving the quality of conservation decisions, as well as decisions about land use and natural resource management.

Heritage programs are designed to promote biodiversity conservation in two principle ways. First, heritage programs help set priorities for conservation by identifying those species and ecosystems that require special attention because of their rarity, endangerment, or exemplary nature. In turn, heritage biologists develop detailed information about the location and condition of these species and ecosystems and about the areas important for their survival. This information can then form the basis for proactive conservation work.

Second, heritage programs help reduce or avoid unnecessary damage to these biological resources that might result through economic development and land use activities. All too often, sensitive species and ecosystems are the victims—often unintentionally—of land development activities and natural resource extraction and management practices. Many agencies, corporations, and individuals involved in activities such as farming, mining, forestry, or construction are attempting to operate with more sensitivity to the natural environment, or are being required to do so by Federal, state, and local laws. Avoiding or reducing impacts to these ecological resources requires knowledge of their existence and distribution before, rather than after, potentially damaging activities occur. By providing a readily accessible source of information about the location of endangered biological resources, heritage programs allow biodiversity concerns to be taken into account early in the land use planning process. Doing so can help decrease the conflicts with environmental regulations that corporations and other landowners may face; at the same time, it can allow agencies and citizens to review the potential impacts of proposed projects on rare and endangered species and important habitats and can help ensure compliance with established policies.

The unifying characteristics of all Natural Heritage Network programs are their commitment to gather, organize, and distribute reliable biodiversity information and their use of a standard inventory and information management methodology. In addition to the locally based heritage programs, the Association for Biodiversity Information and The Nature Conservancy work to support the network as a whole by providing and maintaining a central database of information.

Regional distribution mapping is now performed by applying statistical or rule-based models of species habitat preferences to digital maps of the relevant habitat factors. The U.S. Geological Survey's Gap Analysis Program is using such a rule-based approach to predict regional distributions of relatively widespread terrestrial vertebrates by mapping suitable habitats (usually defined by general vegetation types and hydrological features) within the known range limits of the species. The recently published *Atlas of Oregon Wildlife* serves as a good example of the products that derive from this approach (Figure 23).

This approach has also been adopted by the LEAM™ lab as a means of quantifying the impacts of growth on the natural environment. To demonstrate the LEAM™ lab's technique, the lab selected a study area outside the northern boundary of Fort Benning, GA (Figure 24). The methodology consisted of identifying suitable habitat for the adult gopher tortoise (assumed to be age 6 or older) based on land use classifications and area-to-perimeter ratios.

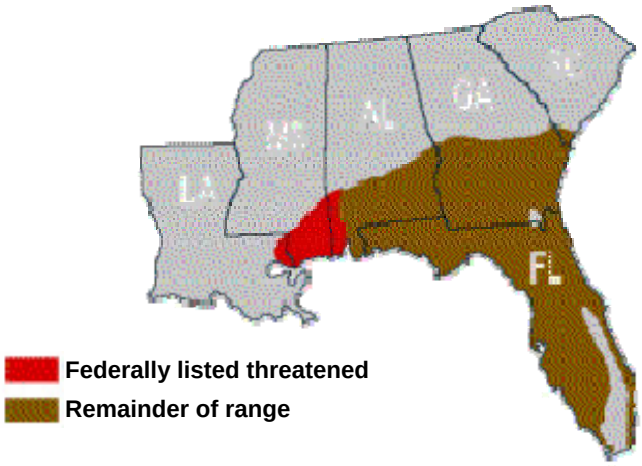


Figure 23. Gopher tortoise habitat.

First, the essential core for the female gopher tortoise was identified as 0.4 to 0.6 hectares and 1.1 to 1.2 hectares for the male. Land use classifications of longleaf pine, Sandhills, and mixed forest identify possible gopher tortoise habitat. It was determined that an area of 19 hectares is needed to support a viable colony of 50 tortoises with a 1:1 sex ratio.

This is what is considered to be the minimum viable colony size. Next, barriers such as roads were overlaid with the possible habitat to identify suitable habitat (19 hectares or more). Patches of less than 19 hectares are eliminated. Figure 25 illustrates possible habitat as it exists today. Figure 26 illustrates possible habitat in 2030 given a base rate of growth (19.3 percent), and Figure 27 illustrates possible habitat in 2030 given the plus-up scenario. If historic growth trends continue into the future, 4.04 percent of gopher tortoise habitat is expected to disappear within the Fort Benning Region. This is a loss of 11,420 hectares of habitat. A plus-up of troops could increase destruction to 5.26 percent or 14,868 hectares.

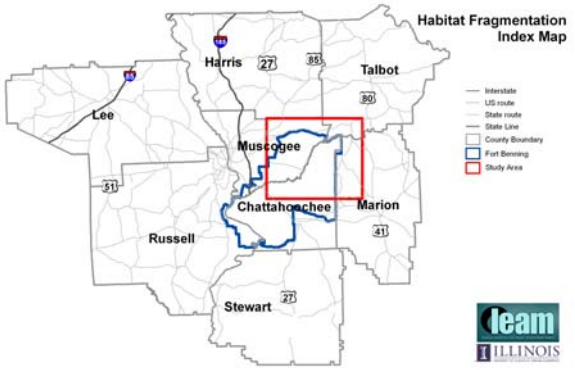


Figure 24. Study area outside the northern boundary of Fort Benning, GA.

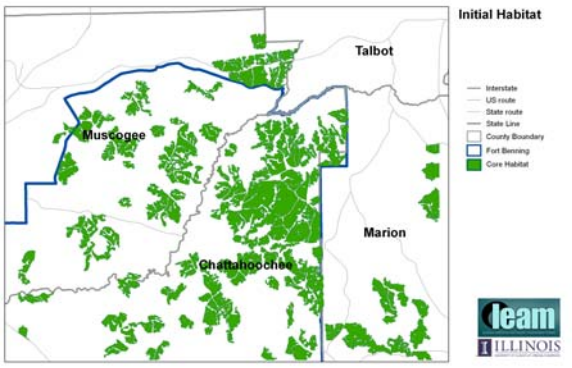


Figure 25. Possible habitat as it exists today.

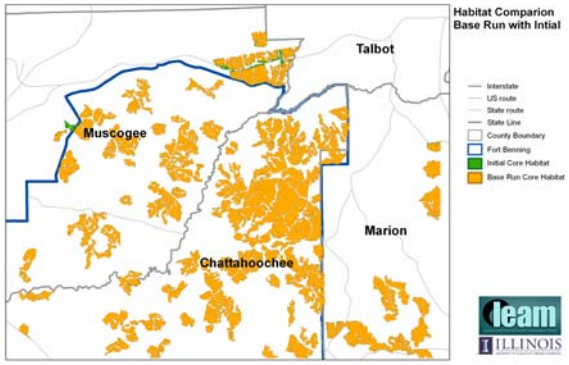


Figure 26. Possible habitat in 2030 given a base rate of growth (19.3 %).

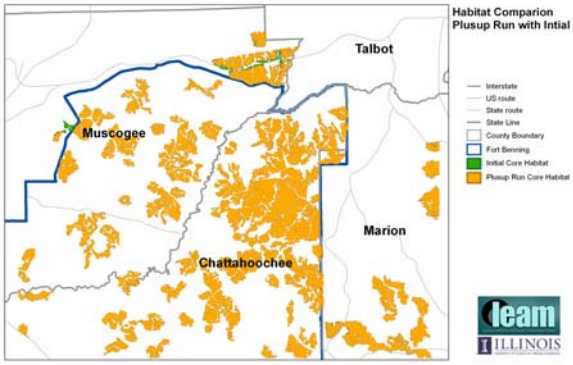


Figure 27. Possible habitat in 2030 given the "plus-up" scenario.

With the use of GISs, this methodology could be applied to the entire Fall Line Region, and could also provide a regional view to determine the criticality of loss of habitat, and hopefully lead to more strategic uses of resources for habitat conservation. Because the gopher tortoise is so critical to the Fall Line Region, other oganizations have incorporated habitat protection into specific projects, including SEMP, Partner's Along the Fall Line, and Southeastern U.S. Ecological Framework Project.

The **SERDP Ecosystem Management Project (SEMP)** is a model effort addressing environmental restoration, sustainable infrastructure, weapons systems, and munitions management on military lands. Fort Benning, GA was selected as the initial host site for SEMP research beginning in 1999. SEMP researchers have undertaken efforts addressing threatened and endangered species habitat within the Fall Line Region:

- Project #1083 Assessment of Training Noise Impacts on the Red-Cockaded Woodpecker
- Project #1394 Automated Acoustic Identification of Bats
- Project #1395 Development and Application of a Physiological-based Framework for Assessing the Biological Significance of Military Activities on Threatened and Endangered Animal Species
- Project #1392 Development of Bioacoustic Tools for Long-term, Non-Invasive Monitoring of Threatened and Endangered Birds
- Project #244 Ecological Biomarkers: Monitoring Wildlife Fauna at DoD Installations
- Project #1302 Impacts of Military Training and Land Management on Threatened and Endangered Species in the Southeastern Fall Line/Sandhills Community
- Project #1262 Methods for Assessing the Impact of Fog Oil on Availability, Palatability, and Food Quality of Relevant Life Stages of Insect Food Sources for Threatened and Endangered Species
- Project #1396 Physiological Response and Habituation of Endangered Species to Military Training Operations
- Project #1303 Regenerating Longleaf Pine on Hydric Soils: Short- and Long-Term Effects on Native Ground-Layer Vegetation
- Project #89 The Effects of Aircraft Overflights on Birds of Prey
- Project #507 Threatened, Endangered, and Sensitive Resources
- Project #1332 Toxicological Effects of Smokes and Obscurants on Aquatic Threatened and Endangered Species.

Several of these projects encompassed examination of protected species associated with the longleaf pine ecosystem, including the gopher tortoise. Findings include maps of species populations, determination if certain ac-

tivities are compromising the health or status or gopher tortoises, species biological profiles, and effects of forest management practices on military training activities as well as TES habitats. Historically, military and human activities have been detrimental to the gopher tortoise. Current SEMP research is identifying new forest management practices that can promote military, civil, and gopher tortoise activities.

In 2001, representatives of Federal agencies and the academic community with ties to the Fall Line/Sandhills region met for a workshop to share information, and develop partnerships for research and ecosystem management. With sponsorship from SERDP/SEMP, the group has continued to meet under the title **Partners Along the Fall Line**. Most recently, the Partners have begun a gopher tortoise management initiative. The objective is to form partnerships that explore ways to extend benefits from the research and monitoring activities through SERDP/SEMP at Fort Benning, GA to other managed land that share ecoregional attributes. This primary concept was to nurture and inform ecoregional partnerships that can exchange information and technology approaches related to ecosystem management. These partnerships would then develop shared goals and objectives for their respective land and for the entire ecoregion.

The **Southeastern U.S. Ecological Framework Project (SEF)** was conducted in 1999-2000 by the University of Florida GeoPlan Center, and sponsored by the USEPA Region 4. SEF is a GIS-based analysis to identify ecologically significant areas and connectivity in the southeast region of the United States. The states included in the project are Florida, Georgia, Alabama, Mississippi, South Carolina, North Carolina, Tennessee, and Kentucky. Figures 28 to 31 show the project results.

The intent is that the product(s) of this study can be used by local, state and Federal agencies in developing a regional atlas of environmental issues and conflicts and threats to the natural ecosystems caused by human environmental impacts. State, local and private entities can use the information to address various environmental resource allocation issues. The SEF project was not species specific. Instead, results illustrate that the Fall Line Region does not house a significant portion of the southeast's existing conservation areas, but rather is identified as a linear hub of biodiversity and thus a priority area for protection. A major obstacle to policy protection within the region is the scarcity of road-less clusters. Roads pose significant threats to species habitat and are difficult to move once in place.

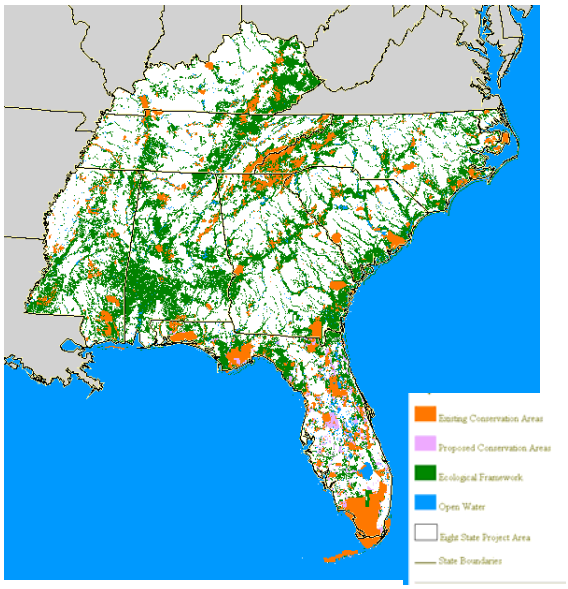


Figure 28. The final SEF model result, showing all optimized hubs and linkages. The Ecological Framework is 43 percent of the project area and 40 percent of the project area's total land area. There are approximately 150,000 kilometers of primary and secondary roads within or adjacent to the Ecological Framework.

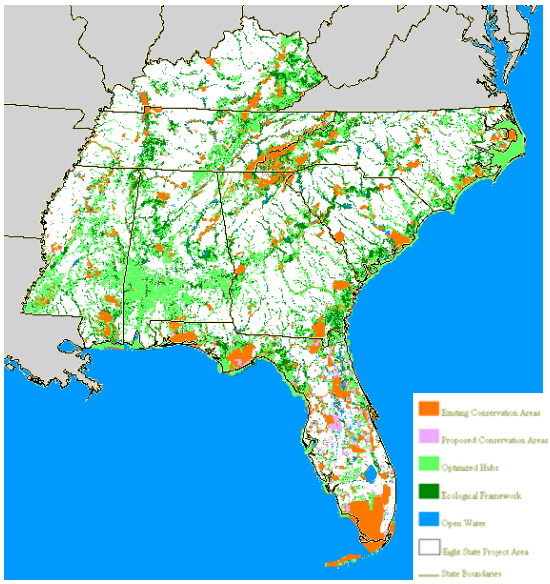


Figure 29. The final SEF model result, showing Ecological Hubs. Hubs are Priority Ecological Areas after exclusion that are 5,000 acres or larger. Hubs are then optimized through a process that includes smoothing boundaries and filling holes of less than 25,000 acres.

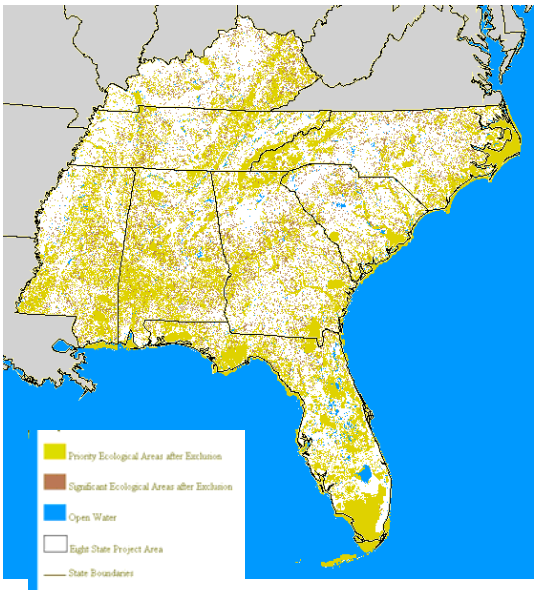


Figure 30. The final SEF model result, showing the cumulative priority ecological areas and significant ecological areas, after excluding urban and intensive agricultural land uses, areas of high road density (3 miles or more per sq mi), areas within 300 meters of intensive land uses, and areas with high densities of intensive land uses.

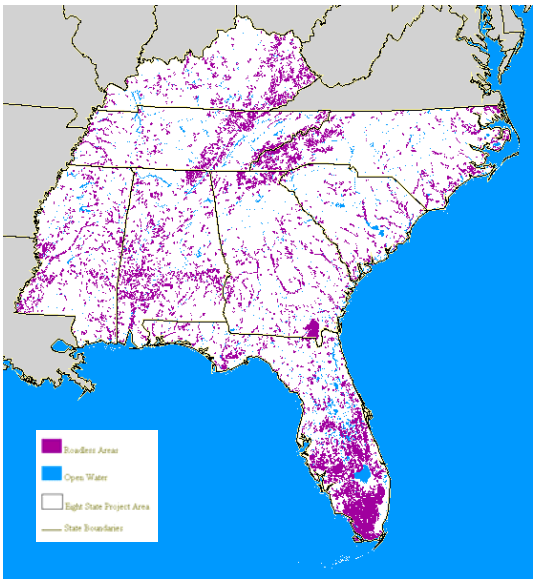


Figure 31. The final SEF model result, showing only road-less areas greater than or equal to 5,000 acres. 12.5 percent of the region is within 2,000 hectare or larger road-less areas. 25 percent of the Ecological Framework is within road-less areas.

Future Sustainability of the Gopher Tortoise

The gopher tortoise is declining throughout its range. TNC documentation and SEMP monitoring programs stress the poor prospects for the species' continued survival. Some researchers have projected that unless something is done to reverse this decline, this species may soon be found only in protected areas. Why is the gopher tortoise in trouble? As shown in the preliminary LEAM™ modeling, it is clear that development is playing a significant role. Habitat loss due to land development and forest management practices pose the most serious threat to the continued survival of the gopher tortoise. Growing populations have destroyed countless acres of tortoise habitat for homes and businesses, and highways have dissected the landscape and been a death trap for tortoises crossing the roads.

Furthermore, changing forest management practices have impacted the natural fire regime. Tree canopies are being allowed to develop, which limits the growth of plants that tortoises depend on for food. These detriments to the gopher tortoise habitat are increasing pressures on the DoD to protect habitats and restrict training activities. However, forestry practices such as tree thinning and the use of prescribed fire help to open up the tree canopy and allow sunlight to reach the forest floor with minimal soil disturbance. SEF has identified sites where such forest management practices should take place.

Yet despite the advances in modeling/mapping techniques and monitoring programs, the barest distribution information exists for the gopher tortoise. Even the simplest questions such as "How long do gopher tortoises live?" and "How do gopher tortoises select mates" remain unanswered. Beyond knowing a species' distribution, information about trends in population abundance and distribution is key to effective conservation and management. Without such trend information, it is difficult to accurately determine the species' status, the causes of population fluctuations, or the effects of management activities.

Perform Gap Analysis

The objective of performing gap analyses is to compare predicted impacts and outcomes to local sustainability objectives. Specific sustainability goals and forecast modeling guide the development of gap analyses. Together, these elements identify any "gaps" between the desired future end state and current projections. Goals were developed from reviewing installation sustainability goals and objectives identified during the ISP process,

and future forecasts came from the landuse and outcome modeling documented within this report. Of the sub-regions modeled, Fort Bragg and Fort Benning are the only installations having published long-term sustainability goals. Fort Bragg finalized 11 goals in 2003 (currently under review). In May of 2005 Fort Benning drafted a set of 12 goals, which are currently in the review process. Also in 2005, Fort Jackson initiated an effort to set long-term sustainability goals. However, at the time of this publication no goals were established and thus a gap analysis was not completed.

The gap analyses, contained in the Appendixes I, J, K, and L, highlight sustainability goals addressing energy, water, housing, and education as articulated by Fort Bragg, NC, Fort Benning, GA, and their local communities—Fayetteville, NC and Columbus, GA respectively. The intent is to identify issues causing these sub-regions to fall short of their desired goals. Knowing the potential shortfall an installation or community may face in reaching its goal, aids in the identification of how the desirable future may be obtained. It is the difference between the desired end state and the forecasted end state that define the fertile ground for policy change and course correction.

Energy

Reliable and affordable energy is essential to continued operations on DoD installations as well as sustaining local communities. Federal guidance continues to push for local management efforts. In 1997, the DoD decided that utility privatization was the preferred method for improving installation utility systems. The Utilities Privatization Program remains a driving issue for energy security. A more recent driving force is the Energy Policy Act of 2005 (Public Law 109-58), which implements energy savings programs for both DoD installations and state governments. Both of these actions should have a great impact on the direction of energy policy within the Fall Line Region. Forts Bragg, Jackson, and Benning all are required to privatize their distribution systems and meet the Energy Policy Act's goals. Fort Benning and Fort Bragg have already privatized their utility systems.

Fort Bragg has an active program to reduce energy consumption on base. Unfortunately, current actions are not enough to keep the installation on the glide path for compliance with Federal mandates. The installation is beginning to pursue renewable energy sources to supplement conservation programs and help keep them on track. Of higher concern are regional population growths. A 25.6 percent increase in forecasted sub-region

population threatens local and state energy conservation. The local communities surrounding Fort Bragg have not been as active in managing energy resources and the influx of population is predicted to boost demand and usage of fossil fuels and electricity. The local region's energy consumption is expected to grow 29 percent in the residential sector and 48 percent in the commercial industrial sector. The electric demand in the residential sector alone is expected to grow by about 500 MW, requiring a new, large power plant to meet this load. Fort Bragg accounts for about 10 percent of the total energy consumption in the seven-county sub-region and about 20 percent of Fayetteville's consumption. Regardless of Fort Bragg's on-base efforts, expanding regional consumption rates threaten the continuation of military operations on-base.

Fort Benning, on the other hand, has already met previous energy reduction policy goals and is positioned to achieve Energy Policy Act requirements. They now strive for no net increases in fossil fuel usage regardless of likely gains to mission requirements and population increases. Like Fort Bragg, Fort Benning would like to see changes in the use of renewable energy sources to keep it ahead of the glide path.

Fort Benning's eight-county sub-region is also predicted to experience increasing population—demanding higher quantities of limited fossil fuel resources and endangering mission sustainment. Added to this is the fact that Fort Benning is on the brink of a major period of growth, change, and transformation on base. The combination of Army transformation, Integrated Global Presence and Basing Strategy, and Base Realignment and Closure has mandated an additional 3,662 military personnel and 2,000 civilians/contractors plus family members to Fort Benning between of 2006 and 2011. This not only means increasing on-base population and building square footages, but also immediate increases within the region to support services to the military.

As in North Carolina, the local communities in Georgia that surround Fort Benning have not been active in managing energy resources. The influx of population is predicted to boost demand and usage of fossil fuels and electricity. In the plus-up scenario, the local region's energy consumption is expected to grow a total of 48 percent—54 percent in the residential sector and 27 percent in the commercial sector. The electric demand in the residential sector alone is expected to grow by about 565 MW, requiring a new, large power plant to meet this load. Fort Benning accounts for about 3.5 percent of the total energy consumption in the eight-county sub-

region. Regardless of Fort Benning's on-base efforts, expanding regional consumption rates threaten the continuation of military operations on-base. These additions are forecasted to steer Fort Benning away from its goals.

Sustaining energy on-post and within the local communities requires that decisionmakers, planners, developers, special interests, and politicians perceive their communities as part of a larger system, with the success of any single component dependent on the success of the system.

Water

Both Fort Bragg and Fort Benning have established goals committing themselves to sustainable practices as it relates to the use and discharge of water resources.

Fort Bragg aims to reduce the amount of water taken from its water source, the Little River, by 70 percent and have all discharges meet or exceed North Carolina's high quality water standard. Fort Bragg's 70 percent reduction goal translates into an annual use of 902 million gal. Currently, Fort Bragg consumes 1,300 million gal annually. To reach their goal, Fort Bragg needs to reduce annual consumption by nearly 400 million gal. Given no predicted changes in population or mission, a 400 million gallon decrease in annual consumption appears possible. However, the installation has also gone to great lengths to reach the level of consumption they have—shaving nearly 200 million gal off annual consumption. Thus, dropping an additional 400 million gal of consumption will most likely be challenging.

In terms of water quality, Fort Bragg's goals are loosely defined by the North Carolina Clean Water Act. However, modeling reveals that urbanization is a major enemy to current water qualities. Without land management practices, growth of residential and commercial areas will likely significantly degrade water resources. Couple this with any climate change and Fort Bragg will experience significant challenges.

In its recent history, Fort Benning has maintained a per capita water consumption rate around 81,000 gal annually through the aid of numerous water conservation programs. Thus, it is assumed with no further actions that this rate will continue into the future. However, this is not Fort Benning's desire. Fort Benning's long-term sustainability goal is to reduce per capita water usage 50 percent by 2030 and maintain a zero contaminants

level in surface water runoff by 2015. To reach its long-term sustainability goals, Fort Benning must intensify its water conservation programs. Population increases and urbanization growth forecasted for the sub-region will only accelerate problems related to water quantity and quality. Regional populations are expected to grow by 26.8 percent—resulting in a significant reduction of available water supplies.

Looking at the entire Fort Benning region provides a larger picture of the water situation. Projected water consumption for residential, commercial, and the electric power industry shows significant growth. An overall growth of about 37 percent is expected, including an even larger growth in residential consumption of about 55 percent. Regional consumption for buildings is expected to increase from 154 MGD to 206 MGD. Additional water consumption for electrical power generation is expected to rise by 120 MGD, but the power plants are not local and this will not be felt in the local area. There will probably be a reduction in water usage for agriculture. These trends are probably sustainable, but will significantly stress the region. In addition, over 48,000 acres are expected to convert to urban uses—increasing surface water run-off and the amount of pollutants carried to surface streams and lakes.

Fortunately, water quantity and quality problems can decline with region-wide management actions. Like energy, water is a shared resource whose sustainability is dependent on the cooperation of all of its users. Without a comprehensive regional approach, the Southeast will experience significant watershed problems in the future.

Housing

The Army provides housing support for “accompanied” and “unaccompanied” enlisted service members and maintains housing master plans to address the needs of each. Most recently, the Secretary of Defense directed housing policy to maximize reliance on off-post housing and eliminate out-of-pocket expenses for housing. These are rather lofty goals considering housing environments can be dramatically altered by minimal changes in regional population, socio-economic conditions, and Army transformation. Further complicating matters, predicting these changes are often impossible and reaction measures are slow. The Army intends to mitigate these challenges through a combination of traditional military construction, increases in the Basic Allowance for Housing (BAH), and privatization of housing units through the RCI program.

Fort Bragg privatized its family housing units on-post through RCI beginning in FY2002. The program upgraded the inadequate housing units and added additional units. Barrack upgrades are scheduled to begin in FY2008. Currently, Fort Bragg is envisioned to maintain its current populations and mission capacities. As long as this remains true, the installation is predicted to have an adequate housing supply. If, however, Fort Bragg were to receive additional brigades and as a result require additional housing, there is little developable land within the installation boundary to construct the required buildings. Fort Bragg would have to look to Fayetteville to support any additional housing needs. Yet, historically Fayetteville has experienced significant housing shortages. In recent years, Fayetteville has managed to slowly recover from its housing shortage. However as a result, housing costs have become a growing concern. Today, housing costs within Fayetteville are well above state and national averages. This jump in costs has occurred within the last 5 years. As regional populations continue to grow, housing construction will attempt to keep pace by increasing housing values. These increasing values result in an increasing BAH from the Army. As the Army aims to eliminate out-of-pocket expenses, the cost of housing for the Army at Fort Bragg is certain to increase.

Like Fort Bragg, Fort Benning combats housing deficits and scarcity of developable land within the Cantonment area. Fort Benning is also set for dramatic increases in military population—spurring rapid housing construction within the sub-region. It is critical that adjacent counties involve themselves in these changes and begin to plan for the influx of people.

For Benning is in the midst of RCI development and is scheduled to receive barrack upgrades in FY2008. The eight-county sub-region surrounding Fort Benning continues to experience housing deficits coupled with unsustainably low vacancy rates for both owner- and renter-occupied units. In other words, the difficulty residents already experience in obtaining housing is predicted to heighten. Looking at housing affordability, local values are falling further behind state and national averages. Within some sub-regional counties averages are as low as half of the national average. The slow rise of property values surrounding Fort Benning favors Army BAH housing expenditures.

Education

A significant element of family readiness is an educational system that provides a quality education to military children. Although the DoD often

maintains school districts for those children living on-base, approximately 80 percent of military children attend school in a local educational agency (LEA). In most local school districts, operating funds are generated by state and local taxes. The presence of a Federal military activity in a school district increases enrollment yet reduces the tax base by the removal of property from the tax rolls. Partnerships between the DoD and LEAs strengthen the educational system, yet, two factors still significantly impact educational resources—Army transformation and the Army's housing privatization initiative.

School-aged children associated with the military stationed at Fort Bragg compose over 30 percent of Cumberland County School District's enrollment. Changes on-base heavily impact the LEA. Although Army transformation are not predicted to affect school-aged children on base, Fort Bragg's recent privatization of housing is having significant impacts. Due to land scarcity, several hundred homes were selected to be built on a tract of installation land located approximately 15 miles from the main installation, other military housing, and the DoD schools.

It is still unclear which school district will ultimately be responsible for educating these children, whether districts will have the necessary resources to offer a quality education, or what resources will be needed by either school district. Further more, DoDEA master planning recommends the transfer of Fort Bragg schools to Cumberland County School District. The transfer of DoD schools to Cumberland County School District would place an extra burden on already economically stressed school districts. (Every school district within the sub-region is at enrollment capacities.)

Fort Benning and its sub-region must address issues related to both Army transformation and housing privatization in the near future. Transformations are predicted to increase Fort Benning's student enrollment by 9,430 students within the next 5 years. For a school system already at capacity and with limited funding for building maintenance, operation, and improvements, this is a dim future. The installation has begun a master planning process to address these issues. It is still unclear if actions will be proactive enough to ensure a smooth transition and maintain family services in support of military readiness.

Added to this issue is Headquarters' recommendation to transfer Fort Benning schools to Chattahoochee County School District. Installation officials and parents express concerns about the quality of Chattahoochee

County schools and their ability to serve the students. Housing privatization at Fort Benning is set to begin in 2008. This has potential for severe impacts on the educational system.

Ensuring the availability of resources for a growing student population requires detailed planning as to who will take responsibility for educating the students and providing the necessary space, supplies, and funding.

7 Strategic Intervention Opportunities

The Fall Line is a region of diverse communities separated by expanses of undeveloped land. This chapter describes current techniques for addressing local land use decisions of particular interest to local communities within the Fall Line Region, and provides an introduction to methods for determining strategic points for policy change. It also identifies key forces and discusses strategic interventions needed to meet sustainability objectives in the Fall Line Region. Highlighted issues include: protecting military training lands; managing urban development; addressing soil erosion, sedimentation control, and drinking water quality; and protecting and restoring habitat. Regional efforts already underway are also briefly discussed.

While the urban areas are economically sound, undeveloped land separating urban areas often supports a low economic quality of life. Since undeveloped land has much less economic value than urbanized/developed land, new development in these areas often proceeds with inadequate planning, which leads to unsustainable growth. Strategic Interventions can identify sustainable development options for those lands that will experience the least negative impacts from development. This planned development can serve the needs of the installation and the surrounding region by optimizing the availability of military training while being sensitive to local concerns, including economic welfare.

Existing and potential mitigation strategies can be categorized in several ways. The first way to categorize mitigation strategies is by the level of management. An example of this is government initiatives that encourage land preservation and compatible land use. These can be implemented in such a fashion as to encourage and protect the military presence. On the Federal level are programs such as those addressing agriculture that can be used to preserve farmland adjacent to military installations. State-level efforts include legislation and model land use plans. Local efforts include zoning and planning implementation programs.

A second way to categorize mitigation strategies is by area of focus. For the purposes of this study, strategic interventions can address issues such as water quality, air quality, energy availability, availability of educational assets, and Threatened or Endangered Species (TES).

A third way to categorize mitigation strategies is by their promulgating authority. Some initiatives are sponsored by the government; others are associated with non-governmental coalitions or organizations.

It must first be said that there is an inter-connection between land use controls, and social and economic trends, and public policy. Governmental and judicial bodies usually attempt to make land use policies responsive to emerging concerns and developing needs. Conflicts result from situations in which localities attempt to block or ignore those needs or from situations in which the response is challenged as an overextension of police power. The complexity of urban and rural issues and the growth of urban areas place constant tension on the land use process.

Protecting Military Training Lands

Military areas in the southeastern United States contribute to their regions' economies. However, training in the region is experiencing increasing threats. A significant reason for this is the direct and indirect effects of urban development. It is a dilemma for many communities in the region how best to sustain a continued strong military presence while at the same time addressing the demand for development.

A community seeking to protect military training lands must: (1) limit development near predominantly military areas, and (2) provide for development away from prime training lands. Success in protecting training lands depends largely on creating the appropriate planning options that result in balanced development patterns. Communities may consider various techniques to protect military training lands, including: sliding scale zoning, purchase of development rights, and conservation partnerships.

Sliding scale zoning limits the number of lot splits allowed in agricultural or wooded areas for additional uses. The number of allowed divisions (or lot splits of land) depends on the size of the parent parcel. The larger the original parcel, the higher the number of splits allowed, up to a cap (established by the community). In essence, this is a transition or buffer zoning technique used to isolate training operations from higher-intensity uses.

The purchase of development rights is a voluntary partnership between the landowner and an outside party (in this case, military installation) putting a permanent restriction on development of the land. In return for preserving their land or agriculture for woodland, the landowner

receives a cash payment. Additionally, local governments may establish a Preservation Fund. This fund provides grants to local units of governments for the implementation of local purchase of development rights.

Conservation partnerships between installations and local governments foster the purchase of land or easements around installations that can be used as buffers protecting military training and urban development from noise and safety concerns as well as environmental priorities such as habitat protection, water quality, and air quality. Often the purchase is made by a third party or agency such as The Nature Conservancy—interested in a specific conservation priority. The purchase of an easement is a restriction on private property, which is legally binding on present and future landowners. Initiation of easements by the landowner is voluntary. However, after signing, the easement is an enforceable document binding both parties. When an owner places a conservation easement on land, certain rights are transferred to another person or organization. When the easement document is properly signed and recorded in the county land records, owners can no longer exercise the rights that have been given up.

Managing Urban Development

New development is both necessary and desirable to maintain and improve the quality of life of the people who currently live in the community as well as for those who will live there in the future. New development that is compatible with the natural and cultural heritage of a community is an important consideration to those who live there. The planning process should capture the community's vision of how it wants to shape and integrate land uses into the future development scheme, and the desired type, design, quantity, and location of development. The master plan and zoning ordinance continue to be the primary land use management tools for shaping development. Specific tools may include: master planning, zoning ordinances, capital improvement plans, or tax increment financing districts.

The ***master plan*** is a community's blueprint for the future, and should be the first tool consulted in managing future land development. The plan should contain goals, objectives, and policies on how the community will manage the expected residential, commercial, and industrial growth. If farmland protection is a high priority, it must be included as a part of the community's master plan. Public involvement is a vital component to successful protection programs. Farmers, residents, and realtors all need to be included in the master plan process. The master plan should include a map of all prime and unique farmland in need of protection and lands cur-

rently protected under a Farmland Preservation Program; community goals for protecting farmland and prioritizing existing farmland for future protection efforts; and a community's participation or the support of the state

Zoning ordinances regulate the present allowable uses for land and protect public health, safety, and general welfare of a community. These regulations (e.g., densities, lot sizes, setbacks, residential dwelling unit sizes, lot coverage, height, signs, and parking) can play an important part in managing urban growth. Zoning encompasses a variety of tools including conditional zoning, planned unit developments (PUDs), buffer or transition zones, and establishing principal shopping districts (PSDs) or industrial business parks. Conditional zoning may grant a special use within a dedicated zone or specify the location on the property for particular uses. PUDs provide communities with flexibility through innovative designs of residential, commercial, and industrial uses. PUDs vary from clustering of residential buildings to complex mixed-use developments.

To use the PUD technique, there must be some community benefit, typically: preserving some significant natural asset; providing natural buffers, open space, or recreation facilities; or providing a complementary and integrated mixture of uses and housing densities and types. Buffer or transition zones are often employed to provide for compatibility of adjacent disparate uses. For example, the tool may assure that areas between a military training zone and a single-family residential zone or a commercial zone would smoothly transition, or (more appropriately) provide a buffer for the military training lands. Designations of open space in the form of park or playground areas, and clusters of commercial and industrial land uses may additionally ensure compatibility between land uses.

Capital improvement plans (CIP) are short-term plans (typically 5 or 6 years) that identify where major, non-recurring facilities will be provided. The CIP details each capital project, estimated project cost, description, and funding source. Capital items could include such things as transportation facilities, buildings, water facilities, sewage systems, and parks. The overall goal of the CIP is to order and time the community's fiscal expenditures while coordinating public investment with adopted plans and policies to properly manage the city's long-term investments. CIPs work together with zoning and subdivision regulations to provide local governments with an integral instrument for implementing comprehensive, strategic, and development plans.

Tax increment financing (TIF) is a method for raising funds to cover public costs associated with development projects. To initiate tax increment financing, the local unit creates an eligible authority; establishes the tax base (set at the initial year within a specific district); and then uses the tax revenues generated by new development or reassessment in subsequent years that are over and above the initial tax base (the increment) to finance infrastructure improvements within the district. The money captured after the tax freeze goes to the district authority and its projects rather than going to other taxing units within the municipality. The captured funds can be used within the specified district for various allowable uses, as outlined in the pertinent legislation. TIF districts are a form of enterprise zones—geographic areas designated to help to stabilize and foster improvements. The concept may be applied to residential, commercial, or industrial land uses. A major benefit of enterprise zones is to encourage infill development. Infill development helps to bring new taxes to the community while taking advantage of existing infrastructure and discouraging urban sprawl. It may be appropriate for a community to establish specific redevelopment and infill managing techniques.

Soil Erosion, Sedimentation Control, and Drinking Water Protection

Erosion and sedimentation occurs when wind, water, or gravity runoff carries soil particles from an area and transports them to a water body. Excessive erosion and sedimentation leads to various water quality problems that diminish the quality of life in our communities. Urban development is the primary driver of erosion and sedimentation within the Fall Line Ecoregion. Additionally, development increases the possibility of contamination to groundwater sources resulting in problems for areas dependent on groundwater. There is an interrelationship between erosion, sedimentation, and water protection and land use planning. Tools communities can draw from to protect these natural resources include: policies integrated in local ordinances, protection programs, and overlay zones.

Local ordinances are critical components of any effort to protect a community's soil and water resources. Local governments can direct development to areas likely to have suitable soils and groundwater conditions. As part of a site plan review process or a local soil erosion ordinance, communities can require developers to submit and comply with a plan that contains measures to reduce soil erosion and control sediments that do erode. In addition, the regulations may include specific requirements for clearing and grading a site. These regulations may also apply to lumbering land uses. Specific guidance typically addresses drainage patterns, phased

construction to limit soil exposure, restrictions on disturbing steep slopes, and establishment of stream buffers. Site plan reviews and ordinances can also include standards specific to groundwater resources. These recommend practices give particular attention to sites where hazardous substances, wastes, or potential pollution materials are stored, used, or generated. Here practices must be designed to prevent spills and discharges of such materials to the air, surface of the ground, groundwater, lakes, streams, rivers, or wetlands.

A soil or water ***protection program*** identifies potential sources of contamination and uses management to minimize the threats. Key elements of a protection program include partnerships with ?????

Beyond the site plan review standards, communities can use an ***overlay zone*** to protect soil and water resources. An overly zone is a geographical area that is subject to special regulations. For groundwater protection, the geographic area of the zone is typically based on the wellhead zone of contribution 10-year time of travel. This allows for zoning regulations to be placed directly on the wellhead protection area at risk.

Habitat Protection and Restoration

Habitat is an increasingly important quality of life component for many Fall Line communities. While previously viewed as an issue of preserving plants and animals, there is growing recognition about the value of habitat to humans. Preserving and restoring habitat has several benefits. These include: recreational and aesthetic opportunities (e.g., bird watching, wildlife hikes, fishing, and hunting are just a few of the many recreational activities that depend on the availability of wildlife); economic values for homes and businesses; and environmental protection and protection from flooding, resulting from increased storage and/or infiltration of storm water runoff. These important functions are often lost as a result of land use practices that lead to elimination of natural areas, fragmentation, and degradation of the natural resource. The potential loss of habitat could be exacerbated by major land use and demographic changes occurring in developing areas of the Fall Line Region. Forecasts indicate that 190,000 additional acres will become urbanized by 2030; under the high growth scenario this figure is 370,000 acres.

Local land use decisionmaking is a vital element in protecting and maintaining habitat. There are numerous opportunities for local communities to incorporate habitat preservation and restoration into their planning and

zoning process. These include: using the master plan; developing a natural areas plan; using regulatory approaches for habitat protection and restoration; and incorporating native landscaping.

It is necessary to include provisions for habitat protection and restoration in the ***master plan*** if habitat is a valued community asset. Some suggested goals and policy statements for the master plan may be to preserve natural land features and to regulate land use intensities.

The purpose of a ***natural areas plan*** is to identify environmentally significant areas of the community that should be preserved in their natural state and those that can be compatibly integrated with development. Furthermore, the natural areas plan can work toward creating a system of open spaces that are linked to one another through naturally-occurring or human-made corridors. It can be included as a chapter of the master plan, or can be a standalone plan. If standalone, the natural features inventory and background data should be included as part of the plan. The natural areas plan represents an ecosystem approach to open space planning because it helps preserve both the natural areas themselves, and also the functioning of the systems these areas represent. It is an ecosystem approach to land preservation, which takes into account not only the natural feature identified as significant, but also the other adjacent land elements that allow that natural feature to be sustained. A natural areas plan will include inventories, data analysis, and a prioritized list of initiatives.

Enacting new ***zoning regulations*** or revising existing regulations is often one of the most effective ways to protect and restore important habitat areas. *Use*, *density*, and *phasing development restrictions* are specific areas in the zoning ordinance that can affect habitat preservation in the community.

Using plant ***species that are native to the area*** and adapted to the particular climate and soil conditions has many benefits including reducing the need for water, pesticides, and fertilizers; providing habitat protection and restoration; and reducing the amount of storm water runoff. Native plants are the trees, shrubs, flowers, grasses, and ferns that have evolved in a particular area, such as the Fall Line, over thousands of years.

Under Federal law, once the services discover ***endangered species*** on their facilities, they must protect them. At Fort Bragg, the Army has been ordered to protect trees for the red-cockaded woodpecker by restricting

bivouacking, live fire, and digging of foxholes. Faced with "an ever-increasing" need for training space and growing environmental restrictions, the services "invented work-arounds." Some exercises are computer-simulated. In others, training rounds are substituted for live fire. Sometimes, troops cannot bivouac in the training area. In other situations, ground, sea and air elements must train on different ranges.

The Private Lands Initiative at Fort Bragg, NC enables military readiness and environmental protection to be mutually supportive. The *Private Lands Initiative* is a partnership between Fort Bragg, other Federal and state agencies, and the Nature Conservancy in which they buy lands or conservation easements are purchased from willing sellers with the intent of protecting the Sandhills ecosystem, increasing useable training land, and recovering the red-cockaded woodpecker. This is a systemic solution that is beneficial for both national security and environmental protection.

Description of Existing Programs

Federal Programs include those sponsored by the U.S. Department of Agriculture and the U.S. Fish and Wildlife Service. These are generally delegated to state offices for implementation.

State Legislation includes Arizona's Preservation of Military Airports Act and Military Airports Regional Compatibility Project. Although these initiatives are not in the Fall Line Ecoregion, they provide examples of the type of action that a state government can pursue to preserve the economic boost provided by a military presence.

County Initiatives within the study region affect the military presence both directly and indirectly. *Sumter Grows Smart* is an organization within the sub-region of Fort Jackson. One of their initiatives is to limit housing development near Shaw Air Force Base. The Central Midlands Council of Governments is comprised of Fairfield, Lexington, Newberry, and Richland Counties. Lexington and Richland are in the sub-region of Fort Jackson. The Council's goals include environmental planning for water and air quality and land use planning. Their web site contains GIS links to the South Carolina Department of Natural Resources (DNR), Richland and Lexington counties, United States Code (USC), USGS, SC Mapping and Advisory Committee, and the report "Facing Facts: A Study of Issues that Shape Our Region."

Lee County, in the Fort Benning sub-region, has developed a "2005 Strategic Plan" that includes land use legislation to protect property owners and public safety. Muscogee County is part of the *Columbus Consolidated Government*. This organization published the "Vision 2010," which identifies the need for a regional Master Plan. The Columbus vision and goals include commerce, infrastructure, recreation, public safety, health care and sanitary, and government services. Marion County is part of the *Valley Partnership Joint Development Authority*. Other members include the city of Cusseta, Harris County, the city of Manchester, Marion County, Muscogee County, Talbot County, Taylor County, and the city of West Point.

Hoke County, NC is home to Fort Bragg and Pope AFB. Their "County Land Use Plan," adopted in April 2005, includes an inventory and analysis of existing conditions. One stated goal of the Land Use plan is to preserve and protect the rural agricultural nature of designated lands. An objective of the plan is to encourage dialogue with Fort Bragg. The "Richmond County Strategic Land Use Plan," dated July 2000, also aims to "preserve, protect, and sustain the rural agricultural nature" of the county. Specific objectives include clean air and water, preservation of forest land, and a clean environment. The *Lumber River Council of Governments* is part of a system of 17 regional councils covering the entire state of North Carolina. It is a multi-county planning and service area. Other member counties are Bladen, Hoke, Richmond, and Robeson. One focus of this organization is groundwater resource planning and river basin planning.

Military Programs intended to ensure compatible land use adjacent to installations include the Private Lands Initiative (PLI) and the Army Compatible Use Buffer (ACUB) programs. The PLI, in the region of Fort Bragg, was the first of its kind and was the impetus for development of the ACUB program. Both programs consist of public-private partnerships to cost-share the purchase of land titles or conservation easements from willing land owners to minimize incompatible land use. Details of ACUB are contained in the "End of Year Report FY05."

The *Joint Land Use Study (JLUS)* program is an inter-jurisdictional partnership, funded by the DoD, Office of Economic Adjustment, with in-kind contributions from the participating local agencies. The purpose of the study is to increase communication between the military and the community and promote awareness of the strong economic and physical relationship between the post and its neighbors. *JLUS* studies look both at the im-

pacts of current and future post operations on surrounding cities and counties, as well as the potential impacts of community growth on the long-term viability of the military mission. The ultimate goal is to reduce potential land use conflicts, while accommodating necessary growth and sustaining the economic health of the area. The *JLUS* identifies a set of tools and measures that can reduce existing impacts and prevent future conflicts from developing. After the *JLUS* process is over, the surrounding cities and counties, and the military installation, consider further which of the recommended tools may be adopted and implemented. *JLUS* studies have been completed at Fort Bragg and Shaw and Robins Air Force Base within the Fall Line region and are in progress at Fort Benning.

Land Preservation Programs are often the result of public-private partnerships, as described above. A number of NGOs are involved in efforts to preserve open space. Some of the NGOs at work in the study region include the *Trust for Public Land*, the *Conservation Fund*, the *North Carolina Wetlands Restoration Program (NCWRP)*, and the *American Farmland Trust* (AFT). The *NCWRP* is a nonregulatory program that protects water quality through the use of conservation easements between land owners and the State of North Carolina. This protects water quality by maintaining or establishing natural vegetation in a streamside or wetland parcel or buffer. The property under conservation easement cannot be used for commercial, residential, or industrial development or cultivation. More information is available at the *NCWRP* web site through URL:

http://h2o.enr.state.nc.us/wrp/index.htm

Forest Preservation Programs include the USDA Forest Service's *Forest Legacy Program (FLP)*. The FLP, a Federal program in partnership with states, supports state efforts to protect environmentally sensitive forest lands. Designed to encourage the protection of privately owned forest lands, FLP is an entirely voluntary program. The program focuses on the acquisition of partial interests in privately owned forest lands. FLP helps the states develop and carry out their forest conservation plans. It encourages and supports acquisition of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another, without removing the property from private ownership. Most FLP conservation easements restrict development, require sustainable forestry practices, and protect other values.

TES Initiatives include *Teaming With Wildlife*, a coalition of 3,000 organizations nation-wide. Their web site includes links to state wildlife ac-

tion plans, also on the web. Georgia's Comprehensive Wildlife Conservation Strategy can be found at http://www.teaming.com/state_cwcs/georgia_cwcs.htm. Individual State Department of Natural Resources (DNR) often manage TES and other wildlife programs.

Agricultural Land Preservation initiatives include efforts of the AFT, which works with landowners, local organizations and governments, civic groups, and community leaders to protect farmland. The Fall Line Region falls within the Southeast region of the *AFT*. Further information about policy updates and ongoing efforts in the region is contained on their web site www.farmland.org/southeast/index.htm. State web sites are also accessible here. The *AFT*'s *Farm Legacy Program* keeps farmland available for farming through the use of conservation easements. Under the terms of a conservation easement, landowners still hold title to their property and enjoy all rights of ownership. The property cannot be used in a manner that significantly impairs the use of the property for agriculture. See "Farmland Protection: The Role of Public Preferences for Rural Amenities," Agricultural Economic Report No. 815, October 2002.

Agricultural Land Conservation Practices are policies and programs aimed at improving the environmental performance of the agricultural sector to include land use, fertilizers, pesticides, water, and other inputs that can adversely affect the environment and potentially harm human and ecosystem health. One of these programs is the *Conservation Reserve Program (CRP)*. The *CRP* offers incentives for producers and landowners to voluntarily retire highly erodable and other environmentally sensitive cropland from production for 10 to 15 years.

Conclusion

All material provided within this chapter is intended as an initial step to determining strategic points for policy change. By no means are these final recommendations for the Fall Line Region. Stakeholders are encouraged to model the effects of different mitigation strategies, use a combination of strategies, and think creatively for more strategies. Decisions to implement land use policies in one particular area are likely to impact other land use policy decisions. To this end, remembering the potential interrelationships of programs during the planning process and then making land use decisions based on the compatibility or incompatibility of these programs is ideal.

Next Steps

The Fall Line Region is on the verge of a significant environmental, social, economic, and mission changes. The resulting outcomes diverge greatly from local sustainability objectives. Given an understanding of the key forces and sensitivity to the collective interaction of humans, society, and nature, it is vital for sustainability to envision policy and the resulting built environment as interconnections between series of integrated issues. To understand these connections, it is essential to know the magnitude and extent to which change in any issue may affect another issue of integration. This integrative process is a vision, an understanding, a sensitivity to all the components of the built environment that operates from the level of issues to that of regions. This chapter is about that vision. The questions left to be examined are: To what degree can changes in one issue of integration affect other issues? Given these relationships, what are the implications and responsibilities for design and planning?

Backcasting: Creating a Future History

Backcasting is a future technique that helps people create a clear vision of a preferred future; and then to devise strategies to make the preferred future happen. Backcasting is similar to Visioning, however backcasts are not intended to reveal what the future will be, but rather to weigh up a number of possible futures, and decide the implications and preferable options, then to map out steps along the way. Backcasting will provide one preferred option from a number of future possibilities, and a series of ways that the desired endpoint can be achieved (Figure 32).

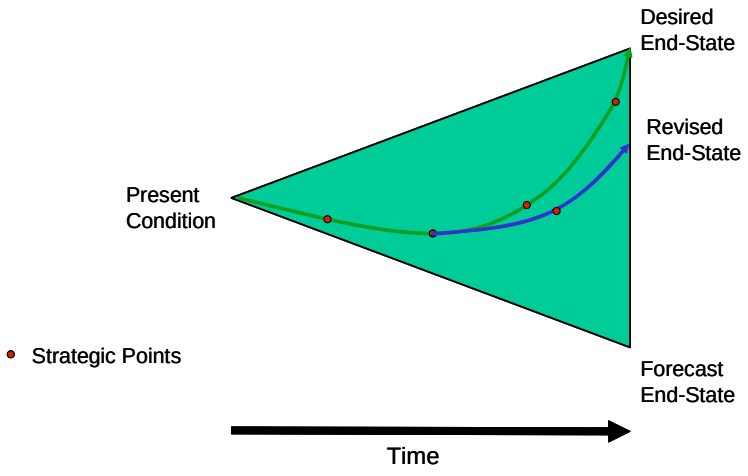


Figure 32. Determine Strategic Interventions.

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Acronyms and Abbreviations

Term	Spellout
ABMP	Army Barracks Master Plan
ACIA	Arctic Climate Impact Assessment
ACSIM	Assistant Chief of Staff for Installation Management
ACUB	Army Compatible Use Buffer
AEPI	Army Environmental Policy Institute
AFB	Air Force Base
AFT	American Farmland Trust
ARHMP	Army Family Housing Master Plan
ASA	Assistant Secretary of the Army
ASAIE	Assistant Secretary of the Army for Installations & Environment
BAH	Basic Allowance for Housing
BCT	Best Conventional Technology
BRAC	Base Realignment and Closure
CBO	Congressional Budget Office
CERL	Construction Engineering Research Laboratory
CIESIN	Center for International Earth Science Information Network
CIP	Capital improvement plans
CRP	Conservation Reserve Program
CWA	Clean Water Act
CWW	Columbus Water Works
DDESS	Domestic Dependent Elementary and Secondary Schools
DNR	Department of Natural Resources
DOD	Department of Defense
USDOE	U.S. Department of Energy
USDOT	U.S. Department of Transportation
DUERS	Defense Utilities Energy Reporting System
ECMI	Ecological Characterization and Monitoring Initiative
EIA	Energy Information Administration
EL	Environmental Laboratory
EMAP	Environmental Monitoring and Assessment Program
USEPA	U.S. Environmental Protection Agency
ERDC	Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory
ERDC-EL	Engineer Research and Development Center, Environmental Laboratory
ESA	Endangered Species Act

Term	Spellout
ESI	Environmental Sustainability Index
ESPC	Energy Savings Performance Contract
FAQS	Fall-line Air Quality Study
FEMP	Federal Energy Management Program
FH	Family Housing
FLP	Forest Legacy Program
FM	Factory Mutual
GAO	Government Accounting Office
GIS	geographic information system
GLT	Global Leaders for Tomorrow
GRIP	Governor's Road Improvement Program
HQDA	Headquarters, Department of the Army
HQRADDS	Headquarters Army DUERS Data System
HQW	high quality water
IEA	International Energy Agency
IGPBS	Integrated Global Presence and Basing Strategy
IMA	Installation Management Agency
ISAT	Impervious Surface Analysis Tool
ISP	Installation Sustainability Planning
ITAM	the Integrated Training Area Management
IWI	Index of Water Indicators
JLUS	Joint Land Use Study
JSEM	Joint Services Environmental Management
LEA	local educational agency
LEAM	Landuse Evolution Assessment Model
LPI	Living Planet Index
L-THIA	Long-Term Hydrologic Impact Assessment
MCEC	Military Child Education Coalitions
MGD	million gal/day
MOA	memorandum of agreement
MSA	Metropolitan Statistical Areas
MTR	Military Training Routes
MW	megawatt
NAR	National Association of Realtors
NASA	National Aeronautics and Space Administration
NCDENR	North Carolina Division of Pollution Prevention and Environmental Assistance
NCEP	National Commission on Energy Policy
NCWRP	North Carolina Wetlands Restoration Program
NEPA	National Environmental Policy Act
NERC	North American Electricity Reliability Council

Term	Spellout
NMFA	National Military Family Association, Inc.
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRI	National Resources Inventory
NRMP	National Resource Management Plans
PDF	Portable Document Format
PERSCOM	U.S. Army Human Resources Command (formerly known as the “Personnel Command”)
PLI	Private Lands Initiative
PNNL	Pacific Northwest National Laboratory (PNNL)
PUD	planned unit development
PWBC	Public Works Business Center
PWC	Public Works Commission
RCI	Roadway Congestion Index
RTLP	Range and Training Land Program
SDI	Sustainable Development Indicators
SDWA	Safe Drinking Water Act
SEF	Southeastern U.S. Ecological Framework Project
SEMP	SERDP Ecosystem Management Project
SERDP	Strategic Environmental Research and Development Program
SETS	Army Secondary Education Transition Study
SIRRA	Sustainable Installations Regional Resource Assessment
SMIG	USGS Surface-water quality and flow Modeling Interest Group (SMIG)
SR	Special Report
SRP	Sustainable Range Program
SRS	Savannah River Site
SSA	Strategic Sustainability Assessment
SUA	Special Use Airspace
TES	threatened and endangered species
TIF	Tax increment financing
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TR	Technical Report
UK	United Kingdom
UPH	Unaccompanied Personnel Housing (UPH)
URL	Universal Resource Locator
USA	United States of America
USC	United States Code
USDA	U.S. Department of Agriculture

Term	Spellout
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGAO	U.S. General Accounting Office
USGS	U.S. Geological Survey
WWW	World Wide Web
YCELP	Yale Center for Environmental Law and Policy

Appendix A: Ecoregion Description

Fall Line Ecoregion Description

The ecoregion encompassing the Fall Line (shown in the Figures A-1 and A-2 with the Fall Line Ecoregion in yellow) was defined using *Ecological Units of the Eastern United States—First Approximation*, published by the U.S. Department of Agriculture (USDA) Forest Service. According to the ecoregion definition, the Fall Line Ecoregion is characterized by rolling to hilly terrain composed primarily of Cretaceous-age marine sands and clays, capped in places with Tertiary sands, deposited over the crystalline and metamorphic rocks of the Piedmont (Keys, Carpenter et al. 1995). The Fall Line Ecoregion tends to be more dissected, rolling and hilly than adjacent ecoregions, with a dense drainage network, and with a different mix of soils. Many of the droughty, low-nutrient soils formed in thick beds of sand, although some soils contain more loamy and clayey horizons. Sandy soils such as Candor and Lakeland are on the ridgetops, while more clayey soils such as Gilead and Vaucluse are on the valley slopes. Some upland areas are underlain by plinthite, and sideslopes tend to have fragipans that perch water and cause lateral flow and seepage. Stream flow is consistent; streams seldom flood or dry up because of the large infiltration capacity of the sandy soil and the great ground-water storage capability of the sand aquifer (Keys, Carpenter et al. 1995).

On drier sites, turkey oak (Quercus laevis) and blackjack oak (Quercus marilandica) grow with longleaf pine (Pinus palustris) and a wiregrass (Aristida stricta) ground cover. Shortleaf-loblolly pine forests and other oak-pine forests are now more widespread due to shifting land uses, fire suppression, and logging (Keys, Carpenter et al. 1995). The region in most areas has soils that are poorly suited to crops due to the droughtiness and rapid leaching of plant nutrients. Many areas are in woodland, and some areas are used for pasture. Portions of the region are also known for their peach orchards, golf courses, and horse farms (Keys, Carpenter et al. 1995).

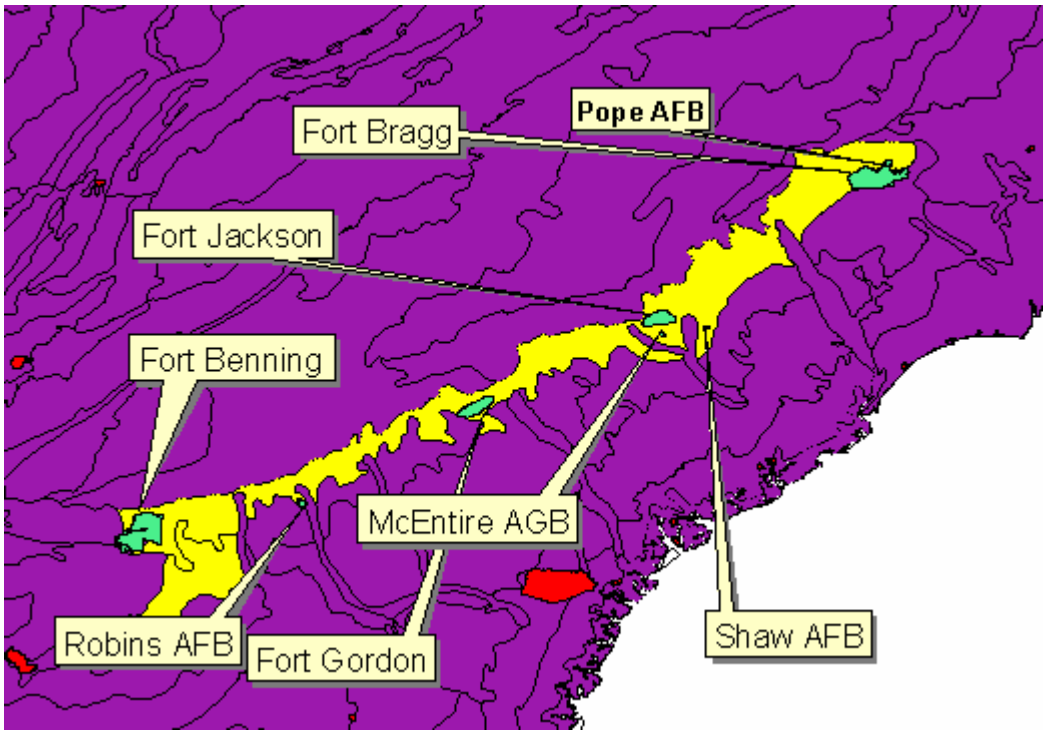


Figure A1. Fall Line Ecoregion.

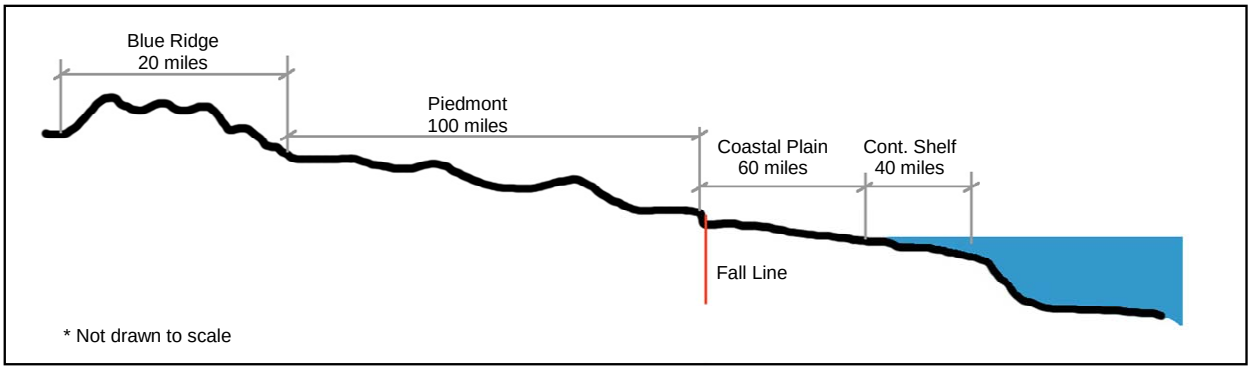


Figure A2. Cross-section of the Carolinas.

Appendix B: Sustainability Initiatives in the Fall Line

National Level Initiatives in the Fall Line

National Environmental Policy Act

The National Environmental Policy Act (NEPA) was passed by Congress in 1969 and established a national policy for the protection of the environment. NEPA mandates that every Federal agency prepare an in-depth study of the impacts of "major Federal actions having a significant effect on the environment" and alternatives to those actions, and requires that each agency make that information an integral part of its decisions. NEPA also requires that agencies make a diligent effort to involve the interested and affected public before they make decisions affecting the environment. There are different levels of NEPA analysis depending on the complexity of the proposed action and potential to impact the environment. The intent of NEPA is to ensure all Federal actions positively impact the physical, social, and economic environment. This means any proposal by DoD installations to construct and operate new range complexes, soldier housing, training equipment, etc. to further support the Mission of the Army will be subject to a NEPA analysis.

Land Use Compatibility

The DoD established the Air Installation Compatible Use Zone (AICUZ), Army Compatible Use Buffers (ACUB), Environmental Noise Management Program (ENMP), and Joint Land Use Study Program (JLUS) in the mid-1970's in response to existing and potential threats of incompatible land development compromising the defense missions at military installations. In particular, a JLUS is a cooperative land use planning effort between affected local government and the military installation. The recommendations present a rationale and justification, and provide a policy framework to support adoption and implementation of compatible development measures designed to prevent urban encroachment; safeguard the military mission; and protect the public health, safety, and welfare. Similar to NEPA, national policy dictates the overall process, yet implementation of land use compatibility efforts require detailed local data. Since 1985, over 35 DoD installations have completed a JLUS—including five of the eight installations located within the Fall Line Region.

Base Realignment and Closure (BRAC)

BRAC addresses sustainability through force transformation. Here a congressional committee is tasked with selecting military installations for mission realignments and closure.

Integrated Natural Resource Management Plan

The Army's campaign plan for Integrated Natural Resources Management Plans (INRMPs) promotes the Army to be a national leader in natural resources management through integrated natural resources management planning that sustains the military mission, supports soldiers and their families, complies with natural resources laws, and conserves and rehabilitates natural resources, which are held in public trust. The Army takes its role as steward of the environment seriously. Being a major land holder in the Fall Line region means protection of the natural resources is an integral part of any analysis.

Sustainable Installations Initiatives

Due to increasing regulatory oversight and environmental impacts, military installations are finding that it is imperative to integrate environmental considerations and stewardship as part of an installation's operations to reduce or eliminate the impact on its ability to train and meet mission readiness requirements. The DoD has already taken steps toward sustainable installations with the promulgation of:

- Executive Order 13101. *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition* (14 September 1998).
- Executive Order 12123. *Offshore Oil Spill Pollution* (26 February 1979).
- Executive Order 13148. *Greening the Government Through Leadership in Environmental Management* (21 April 2000).
- Executive Order 13149. *Greening the Government Through Federal Fleet and Transportation Efficiency* (21 April 2000).

These Executive Orders, along with major environmental legislation such as the National Environmental Policy Act (NEPA), Clean Air Act (CAA), Clean Water Act (CWA), Endangered Species Act, and Sikes Act. Have challenged the DoD to identify, develop, demonstrate, and validate processes, practices, and technologies that focus on efficiently increasing readiness while reducing the military's overall impact on the environment.

The National Defense Center for Environmental Excellence (NDCEE) aligned an effort to support the DoD's sustainability installations initia-

tives (SII) by assessing findings and approaches from existing Army SIIs. The NDCEE will use the assessment to streamline ensuing workshops to be conducted at additional Army priority facilities, as well as laying the baseline for supporting technology transfer endeavors at existing Army SIIs.

Executive Order 13148

Executive Order 13148: Greening the Government Through Leadership in Environmental Management promotes local initiatives by requiring each Federal facility to implement environmental/sustainability management systems by December 2005. Through development and implementation of environmental/sustainability management systems, each agency shall ensure that strategies are established to support environmental leadership programs, policies, and procedures and that agency senior level managers explicitly and actively endorse these strategies.

Local Level Initiatives in the Fall Line

Military installations within the Fall Line have engaged in partnering efforts with local, regional, and state planning agencies in an effort to support the military mission by addressing regional sustainability issues. These participants have formed a partnership to explore strategies for maintaining the health of both the regional communities and the Army installation to ensure that our soldiers today – and the soldiers of the future – have the land, water, and air resources they need to train; a healthy environment in which to live; and the support of local communities and the American people.

Fort Bragg refers to its efforts as *Sustainable Fort Bragg*. Sustainable Fort Bragg has shown that sustainability principles can be successfully incorporated into a military installation mission of ensuring combat readiness of the Army's premier Power Projection Platform while ensuring regional communities have sustainable and productive futures as well. Efforts are still underway at Fort Benning and Fort Jackson. These efforts focus on the special issues predominating in the Sandhills region: lost agricultural lands, controlled burns, and threatened and endangered species habitat for the red-cockaded woodpecker and gopher tortoise. Published long-term sustainability goals and objectives for Fort Bragg and drafted goals for Fort Benning are provided in Appendix D. At this writing, Fort Jackson is still in the beginning stages of its sustainability initiative (Table A1).

Table A1. Comprehensive Planning Efforts.

Fort Bragg, NC	Pope AFB, NC	Fort Jackson, SC
Private land Initiative ISR completed JLUS completed in 2003	JLUS completed in 2003	SII underway
Shaw AFB, SC	**McEntire AGB, SC**	**Fort Gordon, GA**
JLUS completed in 1994		SII underway
Robins AFB, GA	**Fort Benning, GA**	
JLUS completed in 1994 and updated in 2003	Land Exchange Agreement Integrated Training Area Management Program Army Alternative Procedures for Protection of Historic Properties	SEMP SII underway JLUS underway

Natural Resource Management Plan

The *Savannah River Site* maintains a plan for managing the natural resources particular to the Savannah River Site. This plan is intended to serve as a model for natural resource operations, including management, education, and research programs throughout the Sandhills region. Research activities and restoration projects have increased since the original plan was developed in 1991. Of particular note is the recovery of the Federally endangered red-cockaded woodpecker, the development of trails, and the incorporation of new scientific and technical information related to natural resources.

Southeastern Ecological Framework

Sponsored by the U.S. Environmental Protection Agency, the University of Florida GeoPlan Center began the *Southeast Ecological Framework Project (SEF)* in October 1998. The center used GIS technology and landscape ecology principles to identify ecologically significant areas and connectivity in eight states (Kentucky, Tennessee, North Carolina, South Carolina, Mississippi, Alabama, Georgia, Florida) in the Southeast. The center produced a map of ecological hubs and linkages that consisted of 43 percent of the land. Other products included a "Guide to Resources and Regional Conservation Planning," CD-ROMs that include project data, analysis, and results, and a list of "Conservation Tools and Strategies." The project was completed in December 2001. Currently, the Environmental Protection Agency's Region 4 Planning and Analysis Branch use the project's results and data with its partners, including local groups, to guide their conservation decisions. The project data and results were developed to be used at multiple scales. Project managers applied the data to three pilot projects at different scales to show its usefulness. The first was a re-

gion-wide application: prioritization of the SEF to identify the most significant conservation priorities for the region. The second was analysis of the Mississippi Delta with the goal of developing a planning resource to highlight ecological priorities for a variety of natural resource programs, both Federal and non-Federal. The final application was at the local scale: the development of a conservation plan for Murray County, Georgia that included analysis of the usefulness of the SEF for local conservation purposes. More recently, SEF has partnered to develop a regional conservation plan for the gopher tortoise habitat.

SEF efforts include valuable tools for use by other Federal agencies, state and local, and for non-governmental organizations. It is the sincere hope of all involved, that the process and work products can be creatively employed to enhance effective conservation efforts in the southeastern United States and elsewhere.

SERDP and SEMP

The Strategic Environmental Research and Development Program (SERDP) Ecosystem Management Plan (SEMP) was established in 1998 with two primary goals:

1. To establish one or more sites on DoD facilities for long-term ecosystem monitoring
2. To pursue ecosystem research activities relevant to sustaining DoD mission capabilities.

The overall program objective is to plan, coordinate and manage, on behalf of SERDP, an ecosystem management project initiative that focuses on ecosystem science relevant to DoD ecosystem management concerns. This includes:

- addressing DoD requirements and opportunities in ecosystem management research, as identified by the 1997 SERDP Ecosystem Science Workshop 1
- establishing and managing one (or more) long-term ecosystem monitoring sites on DoD facilities for DoD relevant ecosystems research
- conducting multiple ecosystem research and monitoring efforts, relevant to DoD requirements and opportunities, at these and/or additional facilities
- facilitating the integration of results and findings of research into DoD ecosystem management practices.

Still in development, SEMP has developed a database of sustainability projects underway at Fort Benning. Specific projects include: Gopher Tortoise Burrows.

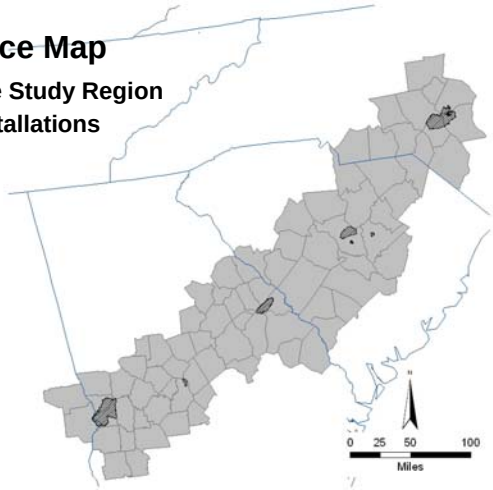
Sustainable Sandhills

Fort Bragg and the North Carolina Department of Environment and Natural Resources undertook the *Sustainable Sandhills* initiative—a regional sustainability initiative in the Sandhills of North Carolina. The Initiative brings together members of Cumberland, Harnett, Hoke, Moore, Richmond, and Scotland counties. Fort Bragg hopes to help civic leaders and citizens alike by taking new steps towards building a sustainable future. The initiative sets a model for communication and interactions between installations and neighboring communities that hopefully will be applied throughout the Sandhills. *Sustainable Sandhills* has fostered *Sustainable Fort Bragg*—a set of long-term sustainability goals for the installation.

Appendix C: SIRRA Analysis Maps

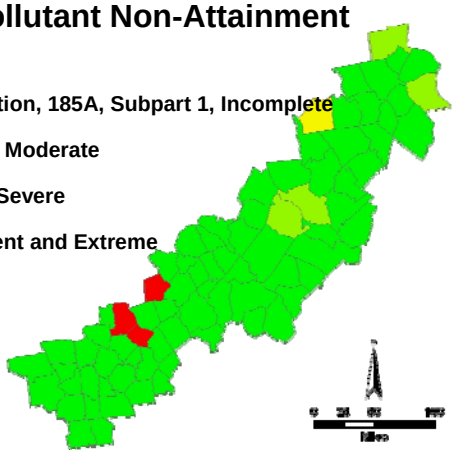
Reference Map

Fall Line Study Region
DoD Installations



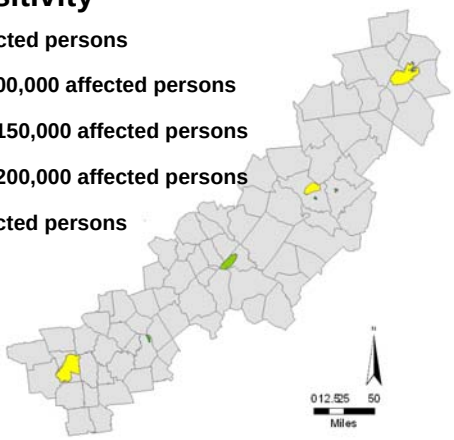
Criteria Pollutant Non-Attainment

Attainment
Primary, Section, 185A, Subpart 1, Incomplete
Marginal and Moderate
Serious and Severe
Non-attainment and Extreme



Noise Sensitivity

<=50,000 affected persons
>50,000 - <=100,000 affected persons
>100,000 - <=150,000 affected persons
>150,000 - <=200,000 affected persons
>200,000 affected persons

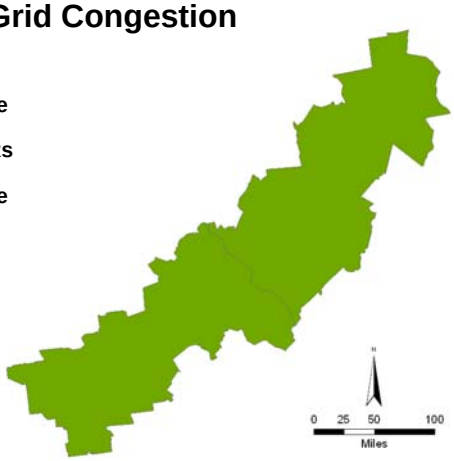


Airspace Sustainability

The SIRRA™ 'Airspace Sustainability' indicator maps were incomplete at the time of this report.

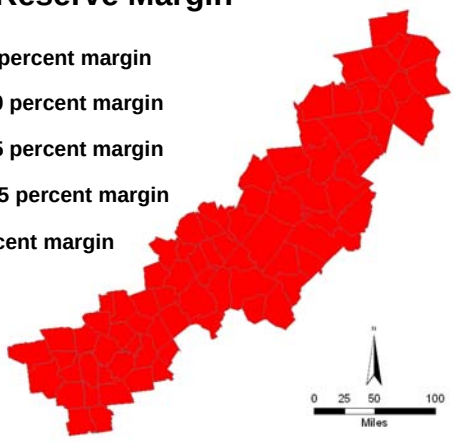
Electrical Grid Congestion

<=50 TLRs
Not Applicable
>50 – 500 TLRs
Not Applicable
>500 TLRs



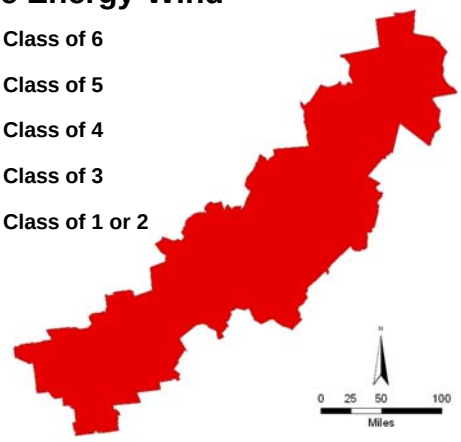
Electrical Reserve Margin

- >20 - <=30 percent margin
- >17.5 -<=20 percent margin
- >15 -<=17.5 percent margin
- >12.5 - <=15 percent margin
- <=12.5 percent margin



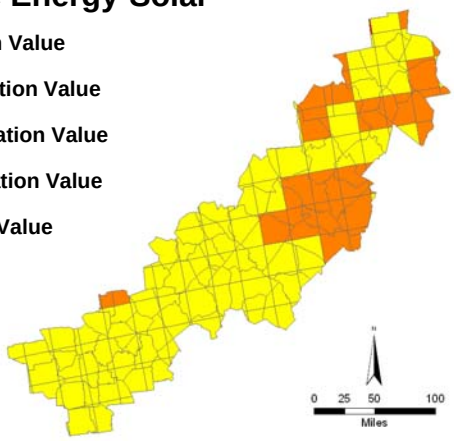
Renewable Energy-Wind

- Wind Power Class of 6
- Wind Power Class of 5
- Wind Power Class of 4
- Wind Power Class of 3
- Wind Power Class of 1 or 2



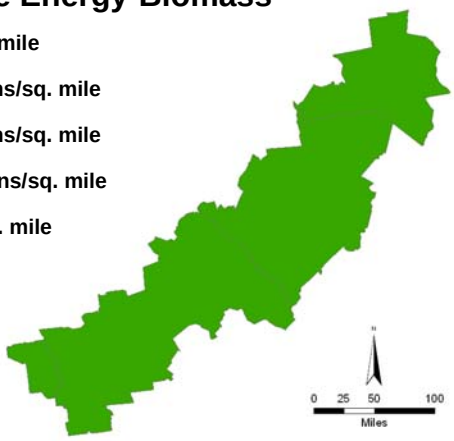
Renewable Energy-Solar

- >=7 Insolation Value
- >=6 – 7 insolation Value
- >=5 - <6 Insolation Value
- >=4 -<5 Insolation Value
- <4 Insolation Value



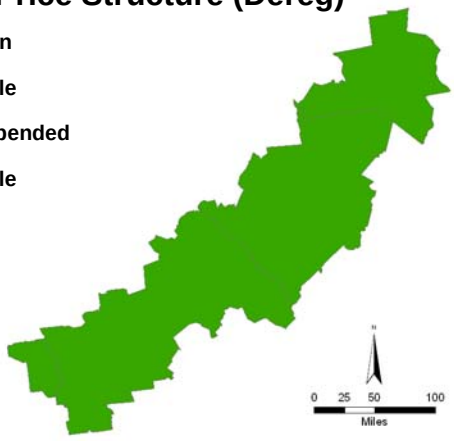
Renewable Energy-Biomass

- >60 tons/sq. mile
- >50 -<=60 tons/sq. mile
- >40 -<=50 tons/sq. mile
- >30 - <=40 tons/sq. mile
- <=30 tons/sq. mile



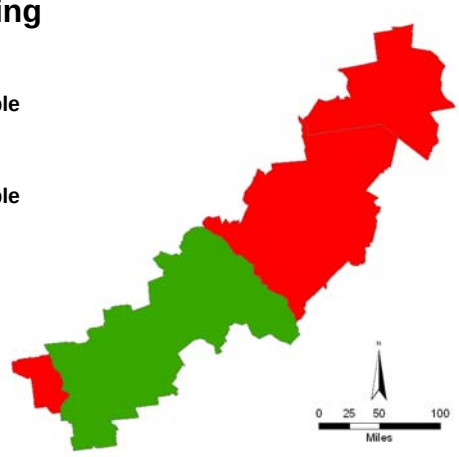
Electrical Price Structure (Dereg)

- No Regulation
- Not Applicable
- Delayed/Suspended
- Not Applicable
- Active



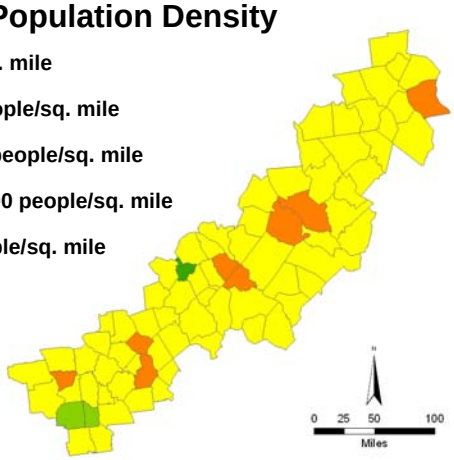
Net Metering

- Complete
- Not Applicable
- Underway
- Not Applicable
- No Action



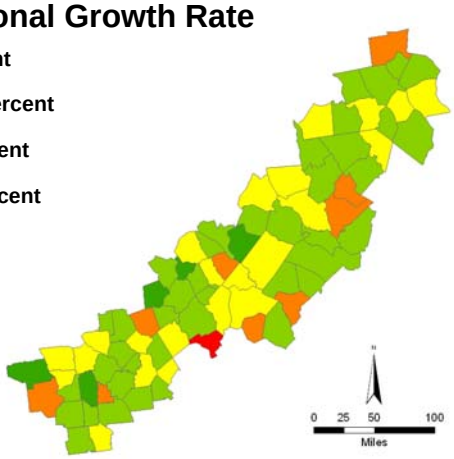
Regional Population Density

- <6 people/sq. mile
- >=6 - <12 people/sq. mile
- >=12 - <247 people/sq. mile
- >=247 - <2,000 people/sq. mile
- >=2,000 people/sq. mile



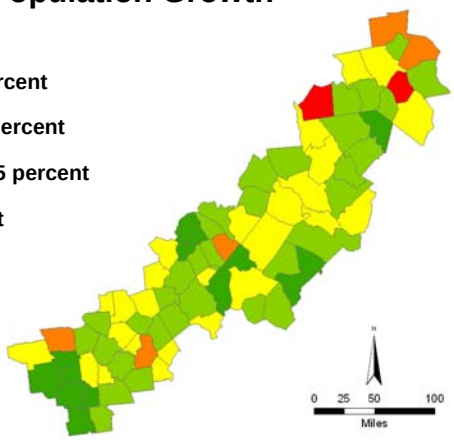
Incr. Regional Growth Rate

- >= -10 percent
- > -10 - <=0 percent
- >0 - <=5 percent
- >5 - <=10 percent
- >10 percent



Regional Population Growth

- <=0 percent
- >0 - <=8.5 percent
- >8.5 - <22.5 percent
- >22.5 - <=36.5 percent
- >36.5 percent

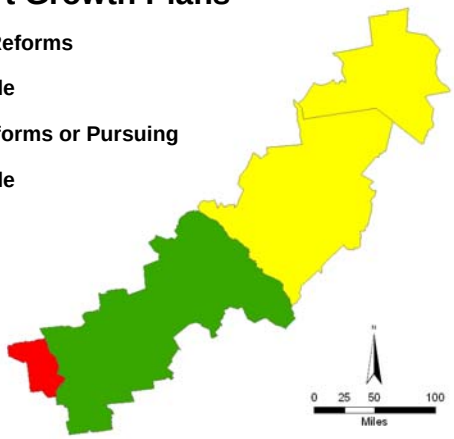


Regional Land Urbanization

The SIRRA™ 'Regional Land Urbanization' indicator map was incomplete at the time of this report.

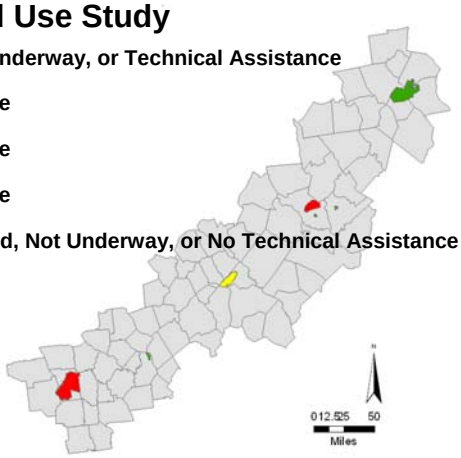
State Smart Growth Plans

- Substantial Reforms
- Not Applicable
- Moderate Reforms or Pursuing
- Not Applicable
- No Reforms



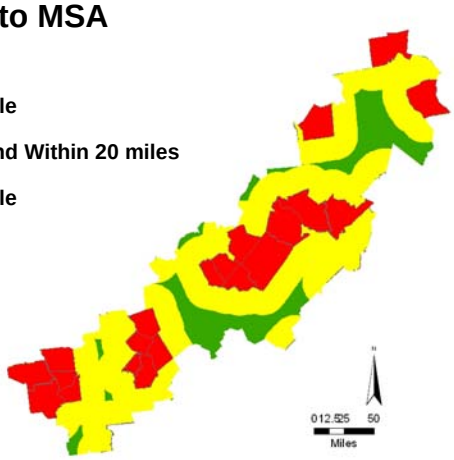
Joint Land Use Study

- Completed, Underway, or Technical Assistance
- Not Applicable
- Not Applicable
- Not Applicable
- Not Completed, Not Underway, or No Technical Assistance



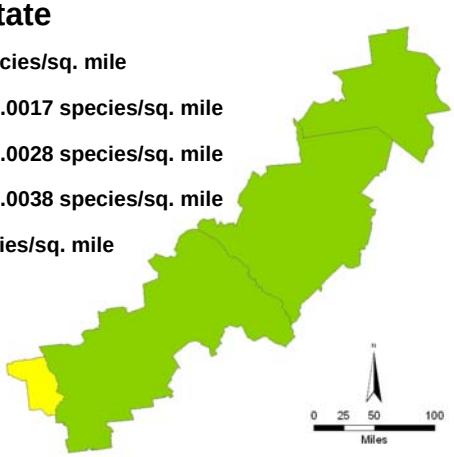
Proximity to MSA

- >20 miles
- Not Applicable
- Not Within and Within 20 miles
- Not Applicable
- Within MSA



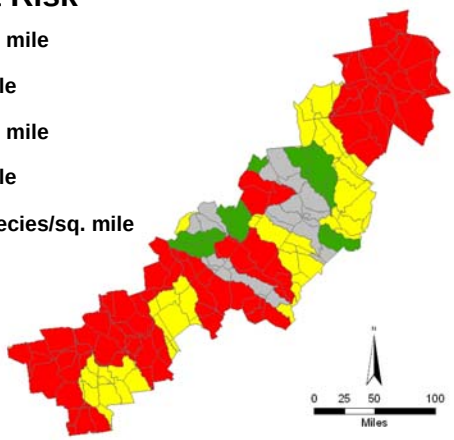
TES per State

- <=0.0005 species/sq. mile
- >0.0005 - <=0.0017 species/sq. mile
- >0.0017 - <=0.0028 species/sq. mile
- >0.0028 - <=0.0038 species/sq. mile
- >0.0038 species/sq. mile



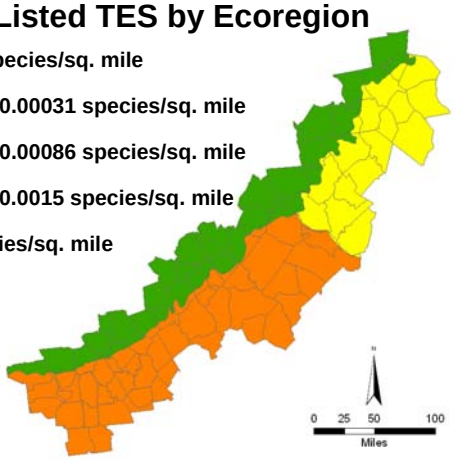
Species at Risk

- 0 species/sq. mile
- Not Applicable
- 1 species/sq. mile
- Not Applicable
- 2 or more species/sq. mile



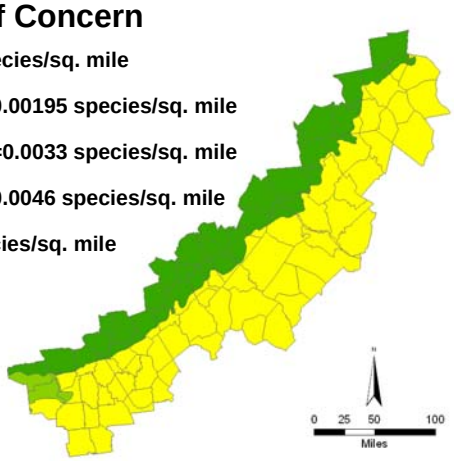
Federally Listed TES by Ecoregion

- <= 0.00016 species/sq. mile
- >0.00016 - <=0.00031 species/sq. mile
- >0.00031 - <=0.00086 species/sq. mile
- >0.00086 - <=0.0015 species/sq. mile
- >0.0015 species/sq. mile



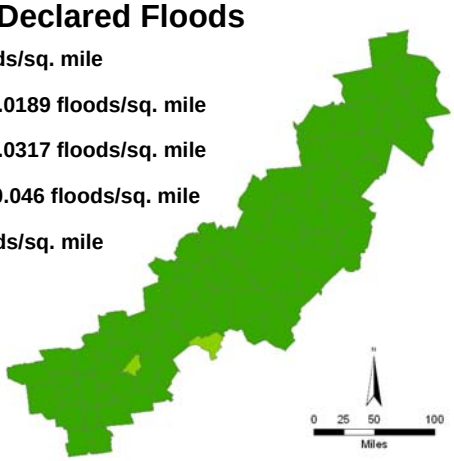
Species of Concern

- <=0.0006 species/sq. mile
- >0.0006 - <=0.00195 species/sq. mile
- >0.00195 - <=0.0033 species/sq. mile
- >0.0033 - <=0.0046 species/sq. mile
- >0.0046 species/sq. mile



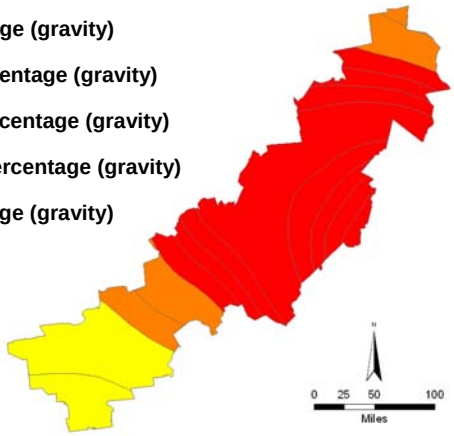
Federally Declared Floods

- >0.0059 floods/sq. mile
- >0.0059 -<=0.0189 floods/sq. mile
- >0.0189 -<=0.0317 floods/sq. mile
- >0.0317 - <=0.046 floods/sq. mile
- <=0.046 floods/sq. mile



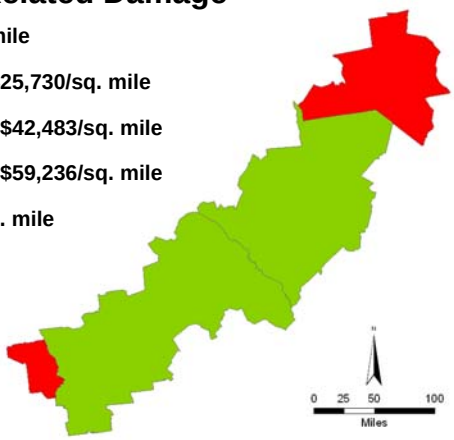
Seismic Zones

- <=7 percentage (gravity)
- >7 - <=8 percentage (gravity)
- >8 - <=16 percentage (gravity)
- >16 - <=24 percentage (gravity)
- >24 percentage (gravity)



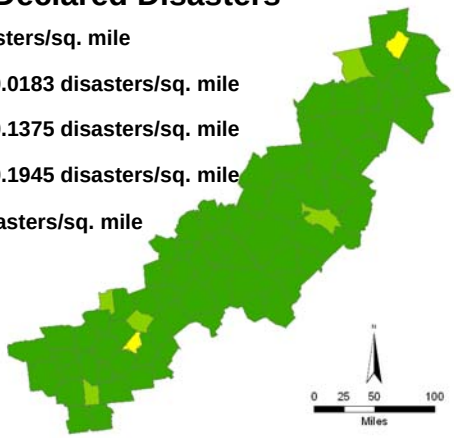
Weather Related Damage

- <$8,977/sq. mile
- >=$8,977 - <$25,730/sq. mile
- >=$25,730 - <$42,483/sq. mile
- >=$42,483 - <$59,236/sq. mile
- >=$59,236/sq. mile



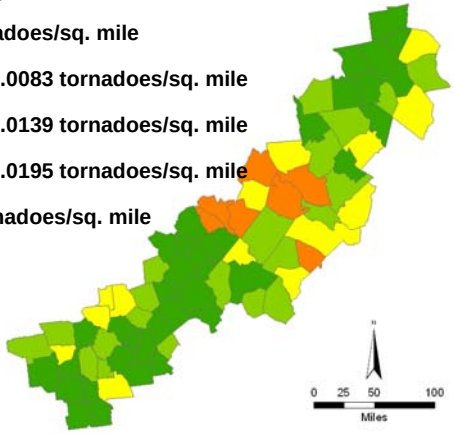
Federally Declared Disasters

- <0.0245 disasters/sq. mile
- >=0.0245 - <0.0183 disasters/sq. mile
- >=0.0183 - <0.1375 disasters/sq. mile
- >=0.1375 - <0.1945 disasters/sq. mile
- >=0.1945 disasters/sq. mile



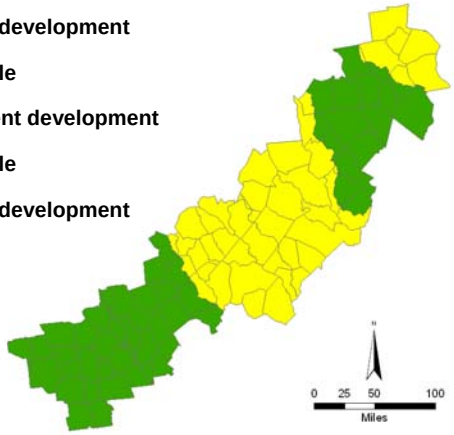
Tornadoes

- <0.0027 tornadoes/sq. mile
- >=0.0027 - <0.0083 tornadoes/sq. mile
- >=0.0083 - <0.0139 tornadoes/sq. mile
- >=0.0139 - <0.0195 tornadoes/sq. mile
- >=0.0195 tornadoes/sq. mile



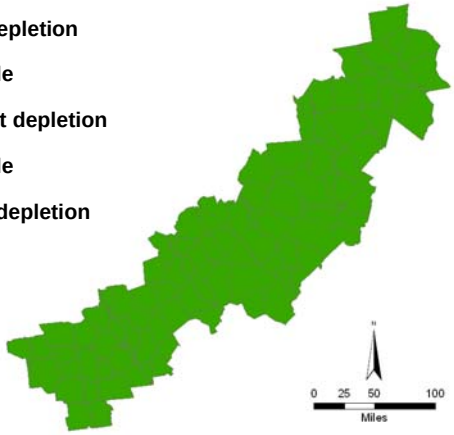
Level of Development

- < 20 percent development
- Not Applicable
- 20 – 85 percent development
- Not Applicable
- > 85 percent development



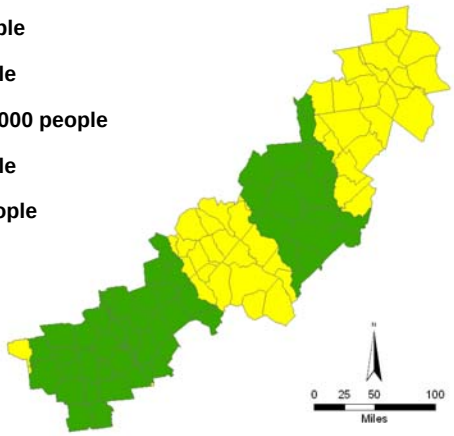
Groundwater Depletion

- < 8 percent depletion
- Not Applicable
- 8 – 25 percent depletion
- Not Applicable
- > 25 percent depletion



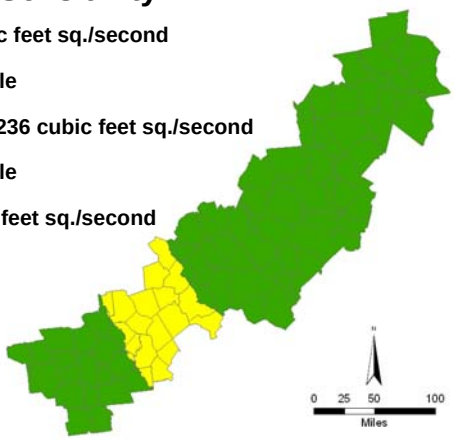
Flood Risk

- < 20,000 people
- Not Applicable
- 20,000 – 200,000 people
- Not Applicable
- > 200,000 people



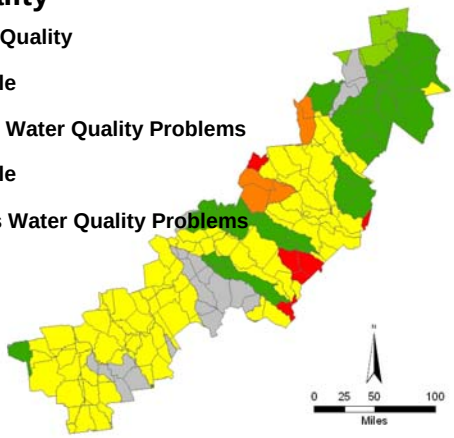
Low Flow Sensitivity

- >=0.236 cubic feet sq./second
- Not Applicable
- >=0.065 - <0.236 cubic feet sq./second
- Not Applicable
- <0.065 cubic feet sq./second



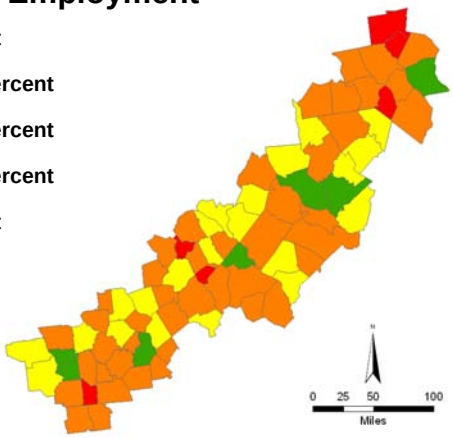
Water Quality

- Better Water Quality
- Not Applicable
- Less Serious Water Quality Problems
- Not Applicable
- More Serious Water Quality Problems



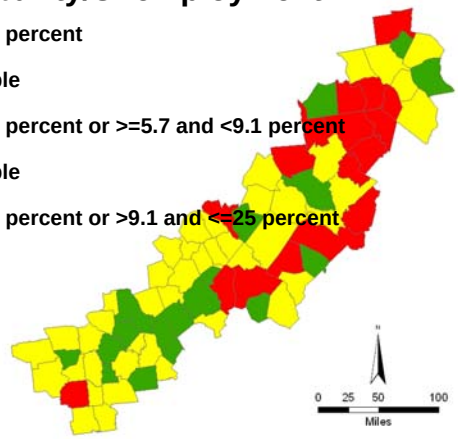
DoD Local Employment

- >4.17 percent
- 2.63 – 4.17 percent
- 1.08 – 2.62 percent
- 0.55 – 1.07 percent
- >0.54 percent



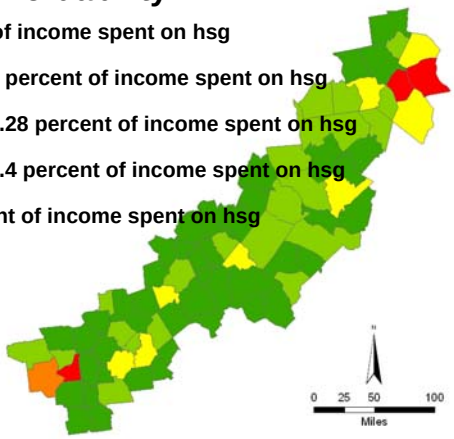
Job Availability/Unemployment

- >=4 and <5.7 percent
- Not Applicable
- >=2.4 and <4 percent or >=5.7 and <9.1 percent
- Not Applicable
- >=0 and <2.4 percent or >9.1 and <=25 percent



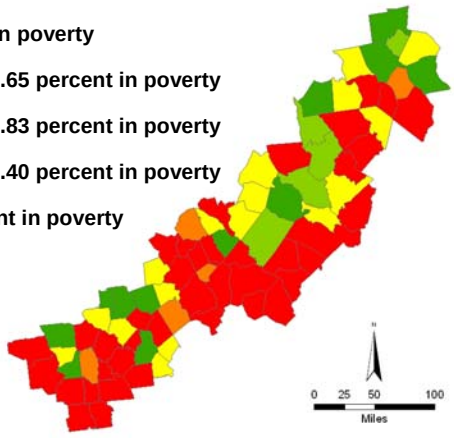
Housing Affordability

- <30 percent of income spent on hsg
- >=30 - <33.15 percent of income spent on hsg
- >=33.15 - <36.28 percent of income spent on hsg
- >=36.28 - <39.4 percent of income spent on hsg
- >=39.4 percent of income spent on hsg



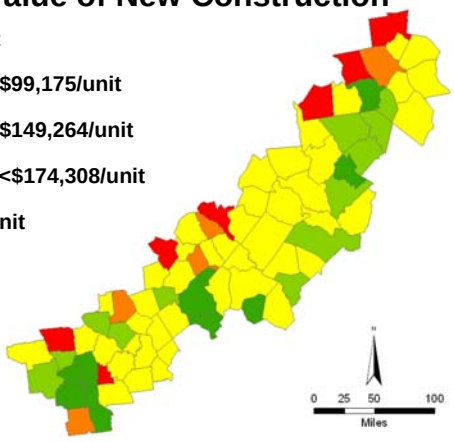
Poverty

- <12 percent in poverty
- >12.08 - <=13.65 percent in poverty
- >13.65 - <=16.83 percent in poverty
- >16.83 - <=18.40 percent in poverty
- >18.40 percent in poverty



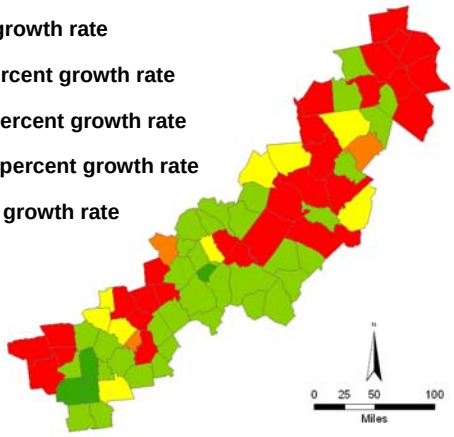
Avg Hsg Value of New Construction

- <$74,131/unit
- >=$74,131 - <$99,175/unit
- >=$99,175 - <$149,264/unit
- >=$149,264 - <$174,308/unit
- >=$174.308/unit



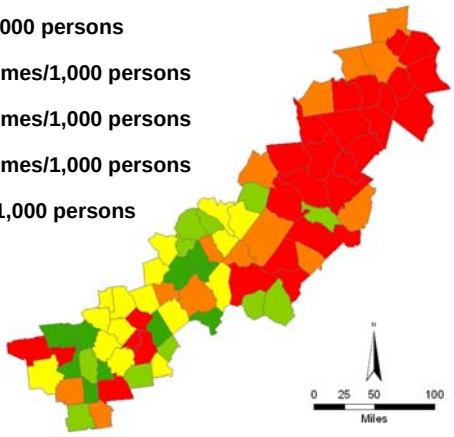
Housing Permits Issued

- <=0 percent growth rate
- >0 - <=100 percent growth rate
- >100 - <200 percent growth rate
- >200 - <=300 percent growth rate
- >300 percent growth rate



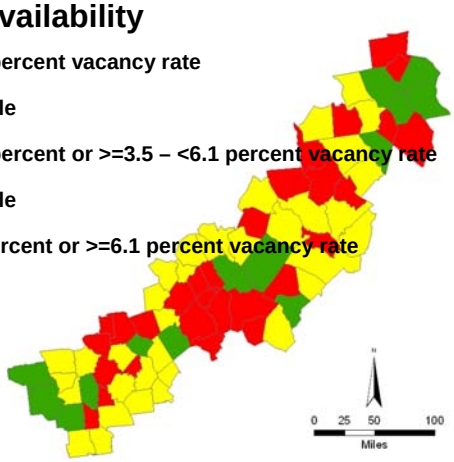
Crime Rate

- <31 crimes/1,000 persons
- >=31 - <46 crimes/1,000 persons
- >=46 - <62 crimes/1,000 persons
- >=62 - <77 crimes/1,000 persons
- >=77 crimes/1,000 persons



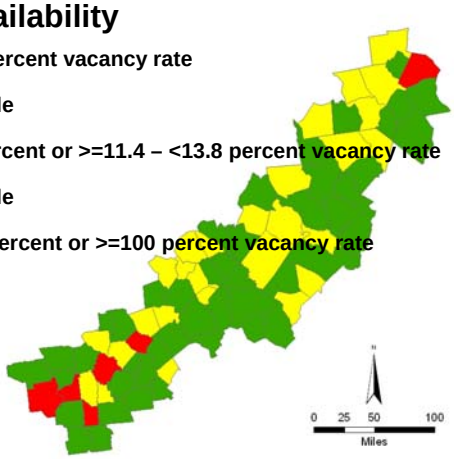
Housing Availability

- >=2.1 - <3.5 percent vacancy rate
- Not Applicable
- >=1.5 - <2.1 percent or >=3.5 – <6.1 percent vacancy rate
- Not Applicable
- >=0 – <1.5 percent or >=6.1 percent vacancy rate



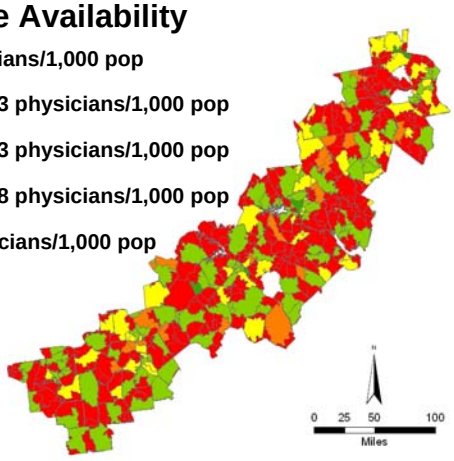
Rental Availability

- >=7 - <11.4 percent vacancy rate
- Not Applicable
- >=4.4 - <7 percent or >=11.4 – <13.8 percent vacancy rate
- Not Applicable
- >=0 – <13.8 percent or >=100 percent vacancy rate



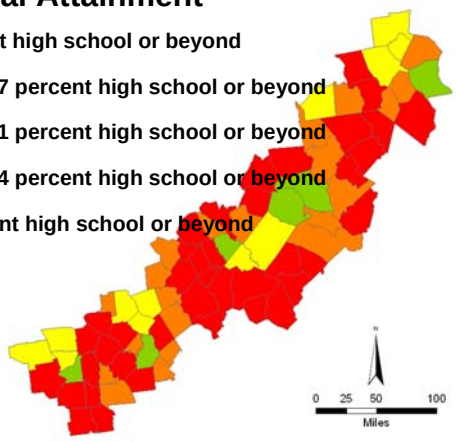
Healthcare Availability

- >2.01 physicians/1,000 pop
- <=2.01 - >0.53 physicians/1,000 pop
- <=0.53 - >0.33 physicians/1,000 pop
- <=0.33 - >0.28 physicians/1,000 pop
- <=0.28 physicians/1,000 pop



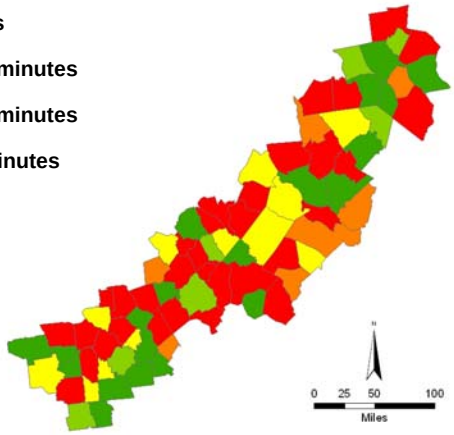
Educational Attainment

- >89.4 percent high school or beyond
- <=89.4 - >82.7 percent high school or beyond
- <=82.7 - >76.1 percent high school or beyond
- <=76.1 - >69.4 percent high school or beyond
- <=69.4 percent high school or beyond



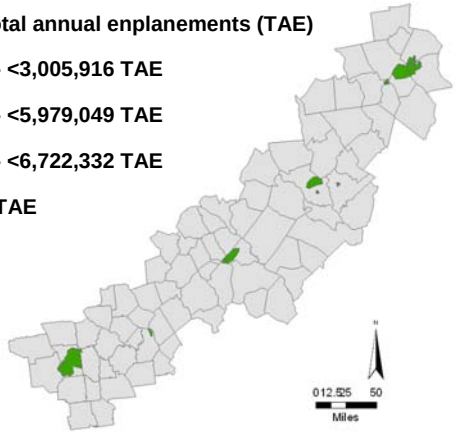
Commute Times

- <=23 minutes
- >23 - <=24.5 minutes
- >24.5 - <=26 minutes
- >26 - <=27 minutes
- >27 minutes



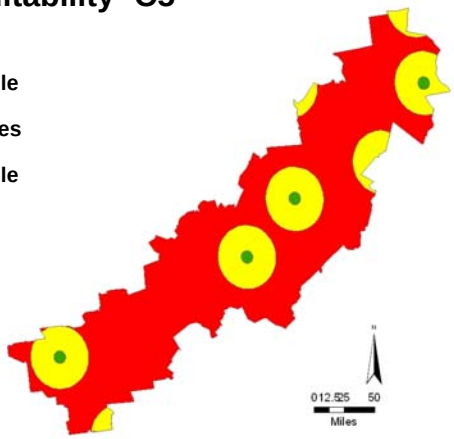
Capacity of Commercial Airports

- <2,262,633 total annual enplanements (TAE)
- >=2,262,633 - <3,005,916 TAE
- >=3,005,916 - <5,979,049 TAE
- >=5,979,049 - <6,722,332 TAE
- >=6,722,332 TAE



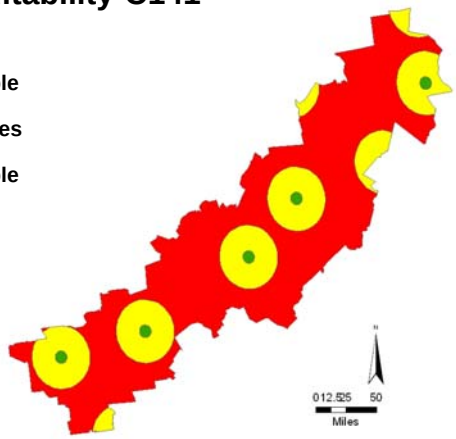
Airport Suitability- C5

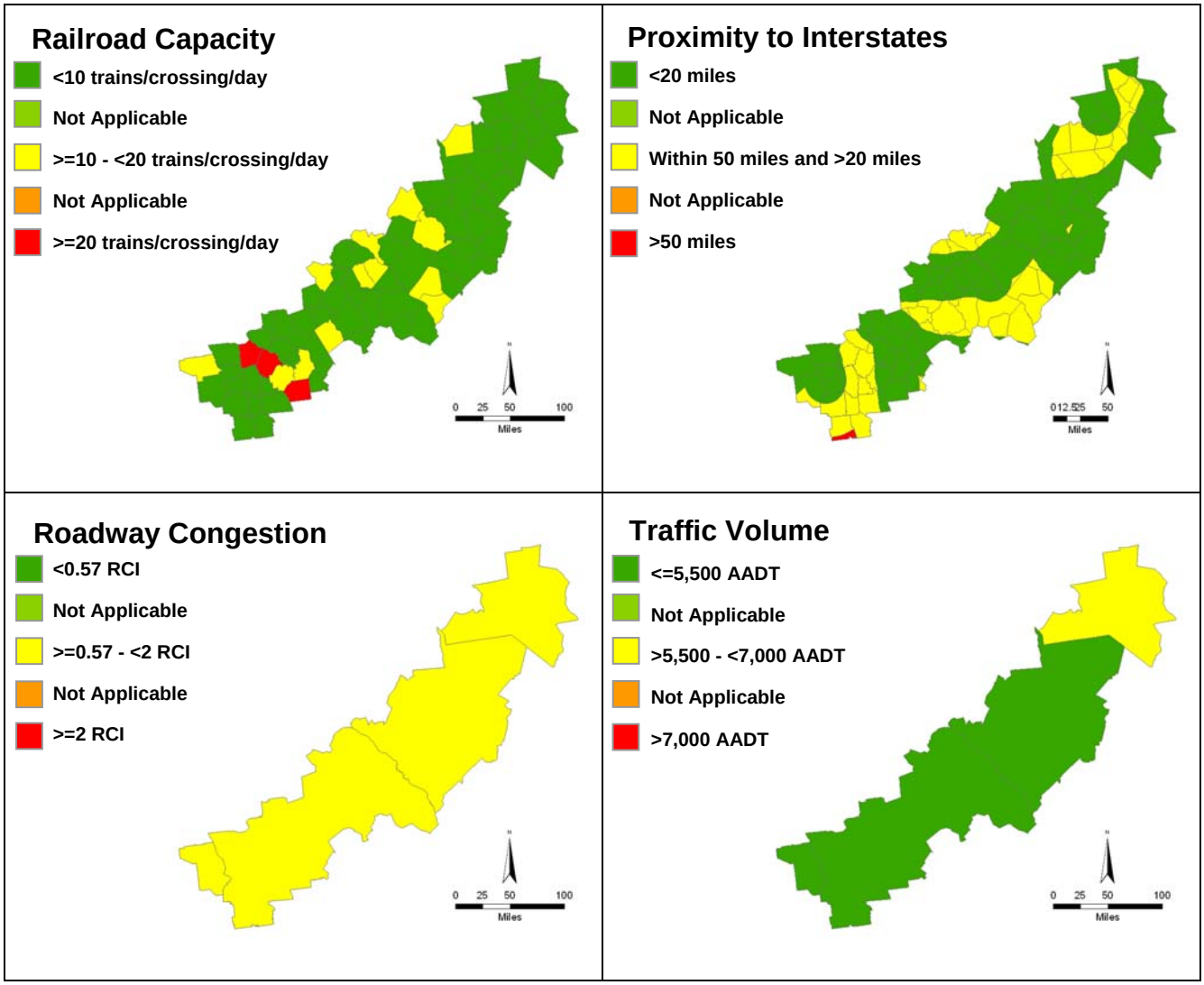
- <=5 miles
- Not Applicable
- >5 - <=25 miles
- Not Applicable
- >25 miles



Airport Suitability-C141

- <=5 miles
- Not Applicable
- >5 - <=25 miles
- Not Applicable
- >25 miles




Railroad Capacity
<10 trains/crossing/day
Not Applicable
>=10 - <20 trains/crossing/day
Not Applicable
>=20 trains/crossing/day
0 25 50 100
Miles
Proximity to Interstates
<20 miles
Not Applicable
Within 50 miles and >20 miles
Not Applicable
>50 miles
0 12.525 50
Miles
Roadway Congestion
<0.57 RCI
Not Applicable
>=0.57 - <2 RCI
Not Applicable
>=2 RCI
0 25 50 100
Miles
Traffic Volume
<=5,500 AADT
Not Applicable
>5,500 - <7,000 AADT
Not Applicable
>7,000 AADT
0 25 50 100
Miles

Appendix D: Sustainability Objectives

Fort Bragg Installation Sustainability
Sustainable Fort Bragg

- Reduce the amount of water taken from the Little River (installation water source) by 70 percent by 2025, from current withdrawals of 8.5 million gal/day (MGD).
- All water discharged from Fort Bragg will meet or exceed North Carolina state high quality water (HQW) standard, by 2025.
  - Develop and implement a comprehensive water resources management program (quality and quantity).
  - Design/upgrade facilities to protect and enhance water quality and quantity.
  - Develop and implement a water education program.
  - Reduce potable water use/waste.
  - Perform Opportunity Assessment to identify projects that conserve water resources (quality and quantity) through conservation, reuse, and reclamation.
- Landfill waste to be aggressively reduced toward zero by 2025.
  - Improve waste management and diversion.
  - Implement soil reuse and recycling program.
  - Implement construction and demolition debris reuse and/or recycling technologies.
  - Implement wood and yard waste reuse/recycling technologies.
  - Implement municipal solid waste reuse/recycling technologies.
  - Implement hazardous waste reuse and recycling technologies.
- Meet minimum platinum standard for all construction 2020 program, and renovate 25 percent of all existing structures to at least a bronze standard by 2020 (using the Leadership in Energy and Environmental Design (LEED).
  - Develop a strong organizational management system that institutionalizes sustainable design concepts.
  - Improve the process for site selection and development for MILCON and OMA construction projects.
  - Optimize water efficiency.
  - Optimize energy and atmospheric impacts.
  - Optimize materials and resources.
  - Optimize indoor environmental quality.
- Adopt compatible land use laws/regulations with local communities by 2005 (RBC Training Division and PWBC Master Planning).
  - Implement and maintain up-to-date Joint Land Use Study/Plan.
  - Initiate and lead state and regional planning forums.
  - Develop state and community relations/education program.

  - Determine potential long-term encroachment issues and develop criteria for prioritizing planning efforts.
  - Sustain the installation to ensure units can train to doctrinal standards.
- Reduce energy use in accordance with Executive Order 13123 (Specifically, to reduce energy use by 30 percent by 2005 and 35 percent by 2010.
  - Reduce energy consumption.
  - Increase the percentage of renewable energy use.
  - Provide incentives for energy users to conserve.
- Develop and implement an effective regional commuting program by 2015.
- Reduce the use of both gasoline and diesel in the non-tactical fleet by 70 percent by 2015 and 99 percent by 2025.
  - Develop and implement an effective regional commuting system.
  - Develop and implement compatible land-use and transportation strategies to decrease automobile dependency.
  - Develop and implement strategies to decrease regional air emissions.
  - Develop and implement strategies as alternatives to car travel.
  - Develop a community outreach and awareness partnership to support regional air-quality initiatives and increase use of regional multi-modal systems.
- Develop an integrated environmental education program for Fort Bragg, its surrounding communities, and interested parties.
  - Develop a training-needs assessment.
  - Implement training program for Fort Bragg community.
  - Periodically evaluate training program effectiveness and develop recommendations for improvement.
  - Develop and implement a public outreach/information program for the Sandhills region.
- Work towards 100 percent Environmentally Preferred Purchasing (EPP) by 2025 for all purchases, including government purchase card, contract, and military requisition.
  - Perform opportunity assessments to identify EPP candidates.
  - Develop policies, training and awareness.
  - Encourage the local market to produce, stock, and promote EPPs
  - Develop tools to measure and increase program success.
- Implement a scientifically based conservation program for natural and cultural resources compatible with military readiness and training.
  - Maintain and implement INRMP (New Goal ... Team being formed in CY04).
  - Maintain and implement ICRMP (New Goal ... Team being formed in CY04).

Fort Benning Installation Sustainability Goal Setting Conference: 9-12 May 2005 Draft Goals

Installation Management

- Achieve procurement of 100 percent sustainable goods and services by establishing an effective procurement network that minimizes life cycle costs, maximizes acquisition options, reduces delays, and establishes system-wide accountability and ownership.
- Fort Benning leads DoD in the provision of Soldier and Family Support Services.
  - Establish one easily identifiable and accessible facility that houses all Human Resource service organizations for soldiers, family members, retirees, and civilians.
- Capture full economic potential for energy efficiency through the use of innovative and sustainable approaches to energy acquisition, management and consumption.
  - No net increase in fossil fuel based energy usage through greater efficiency, conservation and alternate sources, without restricting growth.
  - Partner with energy producer to generate cost-effective energy from alternate sources/methods, such as solid waste, biomass, solar, or fuel cells.
  - Eliminate fossil fuel usage in government tactical and non-tactical vehicles and material handling equipment on the installation by 2030.
- Implement sustainable water acquisition, use and management practices that support the mission of Fort Benning.
  - Implement water conservation best practices to reduce per person usage by 50 percent by 2030.
  - Zero contaminants in surface water runoff by 2015.
- Facilities at Fort Benning meet sustainability objectives.
  - Life cycle considerations are included in planning, design, construction, operations, and maintenance (ONGOING).
  - All new construction projects designed GOLD per LEED by 2006.
  - All revitalization/repair projects meet GOLD LEED by 2006.
  - LEED standards for residential and other construction types established by 2010.
  - Residential projects meet these standards by 2015.

Regional Interaction

- A Chattahoochee Valley community that sustains the Fort Benning mission, enhances quality of life, and protects and restores the environment.

- Become a regional partner and engage regional entities to develop a collaborative bi-state comprehensive plan (water, sewer, transportation, energy, land use, watershed stewardship, housing, economic development, parks/recreation, etc.).
- Develop a compatible use buffer for training, land management, habitat and greenspace.
- Develop a data center (inventory of existing plans, studies, etc.).
- Establish Bi-State legislation (disclosure with deed, coordination).
- Identify funding mechanisms.
- Educate and involve stakeholders on benefits of sustainability and the need for regional partnerships.
- Build local capacity (tools, personnel, etc.) to implement the comprehensive plan.
- Identify, demonstrate, and communicate the benefits (tangible and intangible) of Fort Benning to the region.
- Expand opportunities to integrate Fort Benning and regional communities.

Military Training

- Increase training space (air, land, water, bandwidth) by 50 percent.
- Fort Benning becomes the Army Live-Virtual-Constructive (LVC) Center of Excellence for Joint and Combined Arms Operations.
- Establish world's most innovative Infantry Training System Support Center of Excellence.

Power Projection

- Increase deployment capacity and decrease deployment time for brigade elements by 2030 to 25 percent of FORSCOM standards:
  - Increase capacity and consolidate NODES and infrastructure (rail, airlift, maintenance, line haul, supply).
  - Improvements in transportation systems by land, air, and ports
  - Optimize installation transportation systems.
- Eliminate frustrated cargo and decrease deployment time through reduction and improved management of HAZMAT on the installation and during deployment.
- Provide multi-purpose mob/demob support facility & one stop processing center for joint units & individuals.

Fort Bragg Joint Land Use Study Recommended Goals

Real Estate Disclosure Statements

It is recommended that the North Carolina General Assembly adopt a bill requiring real estate disclosure statements for all parcels of property lo-

cated within 1 mile of the military installations. (Appendix B of JLUS includes a sample resolution.) As appropriate, the real estate disclosure statements should include warnings about potential noise and startle affects from low flying aircraft, blast noise from artillery/small arms fire, and intensive smoke resulting from controlled burns of the managed pine forest areas.

Urban Encroachment

It is recommended that the North Carolina General Assembly adopt legislation that requires local governments in the Fort Bragg/Pope Air Force Base region to permit only low density development (10-acre minimum lot size and no more than one dwelling unit per 10 acres) on all land, which is identified as "critical preservation" and "important preservation" in this study.

It is recommended that the North Carolina General Assembly establish a special trust fund to assist the U.S. DoD, the North Carolina Department of Environment and Natural Resources, the North Carolina Department of Transportation, the Nature Conservancy, and other allied groups with their efforts to make fee simple purchase or the acquisition of development rights for lands identified as "critical preservation" and "important preservation" in this study.

It is recommended that the General Assembly adopt a package of personal tax credits or deductions to serve as an incentive to encourage owners of property identified as "critical preservation" and "important preservation" to voluntarily sell their property or development rights.

Recognizing that the permanent preservation of "critical" and "important" land around the military reservations could result in the potential loss of an increased tax base for local governments, it is recommended that the North Carolina General Assembly create a special trust fund to compensate the effected local governments. The trust fund should provide grants for only certain designated purposes, such as (but not limited to) the improvement/development of educational, recreational facilities and/or economic development initiatives.

It is recommended that the Fort Bragg/Pope Regional Land Use Advisory Commission (RLUAC) develop criteria to prioritize and phase the purchases of the "critical preservation" and "important preservation" land as it becomes available.

Water and Sewer Extension

It is recommended that the North Carolina General Assembly adopt legislation that prohibits the extension of public water and sewer lines to land that is identified as “critical preservation” and “important preservation” in this study.

Military Actions

It is recommended that the military continue to submit new land use and development plans to both the RLUAC and local governments in the region for their review and comment prior to implementation.

It is recommended that Fort Bragg continue to preserve and protect its forested “green belt” area from urban growth and development.

It is recommended that Fort Bragg continue to preserve and protect its natural habitat areas along the perimeter boundaries from destructive military training activities.

Aircraft Low-Level Routes and Low Altitude Tactical Navigation Area

It is recommended that the RLUAC adopt a resolution recognizing and supporting Pope Air Force Base’s assigned and attached units right to continue to fly low-level terrain masking and navigation missions within the six county area that surrounds the Fort Bragg/Pope AFB military complex.

Transportation Policies

It is recommended that the RLUAC initiate a detailed regional transportation study, which measures the impacts of the permanent gate closures, the limiting of public access to Fort Bragg’s Bragg Boulevard, and the construction of the Fayetteville Outer Loop.

Urban Light Pollution

It is recommended that the RLUAC develop a proposed study designed to investigate the effect of light pollution on night training missions. The proposed study should also examine practical ways of reducing the levels of night-light in the Fort Bragg region.

Building Code Revisions

It is recommended that the RLUAC adopt a resolution that supports the required installation of storm windows and doors (or double paned windows) on all new homes constructed within the 62+ decibel noise areas surrounding Fort Bragg, Pope Air Force Base, and Camp Mackall.

It is recommended that local governments, having jurisdiction in the 62+ decibel noise level areas, adopt ordinances requiring the installation of double paned windows and/or storm windows and doors on all new homes constructed within the noise sensitive areas.

Broadcasting, Telecom, and Other Towers

To minimize the potential for future air space hazards, it is recommended that local governments in the Fort Bragg/Pope Air Force Base region revise their zoning regulations to limit the construction of additional broadcasting, telecommunication, and other towers to locations that are consistent with military operational patterns.

Recreational Multi-Use Trail

It is recommended that the RLUAC examine the feasibility developing a major multi-use recreational trail, which could run through Hoke and Scotland Counties—extending from Fayetteville, through the Sandhills Game Lands, to Southern Pines.

Appendix E: 2005 BRAC Recommendations

Department of Defense
Base Closure and Realignment Report
Volume I
Part 2 of 2: Detailed Recommendations
May 2005

Maneuver Training

Recommendation

Realign Fort Knox, KY, by relocating the Armor Center and School to Fort Benning, GA, to accommodate the activation of an Infantry Brigade Combat Team (BCT) at Fort Knox, KY, and the relocation of engineer, military police, and combat service support units from Europe and Korea. Realign Fort McCoy, WI, by relocating the 84th Army Reserve Regional Training Center to Fort Knox, KY.

Justification

This recommendation enhances military value, improves training and deployment capabilities, better uses training resources, and creates significant efficiencies and cost savings while maintaining sufficient surge capability to address future unforeseen requirements. It properly locates Operational Army units in support of the Army's force structure plans and modular force transformation.

This recommendation supports the consolidation of the Armor and Infantry Centers and Schools at Fort Benning and creates a Maneuver Center of Excellence for ground forces training and doctrine development. It consolidates both Infantry and Armor One Station Unit Training (OSUT), which allows the Army to reduce the total number of Basic Combat Training locations from five to four.

This recommendation also relocates the 84th ARRTC to Fort Knox and supports another recommendation, which relocates Army Reserve Command and Control units to Fort McCoy.

These relocations enhance command and control within the Army Reserve, and promote interaction between the Active and Reserve Compo-

nents. This recommendation directly supports the Army's operational unit stationing and training requirements by using available facilities, ranges, training land at Fort Knox, KY (vacated by the Armor Center and School) to effectively and efficiently relocate various Combat Support and Combat Service Support units returning from overseas, and as the installation platform for the activation of a new Infantry BCT. These units are a combination of the relocation of Integrated Global Presence and Basing Strategy (IGPBS) – related units returning from overseas and the activation of units as part of the Army's modular force transformation.

Payback:

The total estimated one-time cost to the DoD to implement this recommendation is $773.1M. The net of all costs and savings to the DoD during the implementation period is a cost of $244.1M. Annual recurring savings to the Department after implementation are $123.3M with a payback expected in 5 years. The net present value of the costs and savings to the Department over 20 years is a savings of $948.1M.

Economic Impact on Communities

This recommendation could result in a maximum potential reduction of 8,521 jobs (6,100 direct and 2,421 indirect jobs) over the 2006 – 2011 period in the Elizabethtown, KY Metropolitan Statistical Area, which is 12.9 percent of economic area employment. Assuming no economic recovery, this recommendation could result in a maximum potential reduction of 834 jobs (497 direct and 337 indirect jobs) over the 2006 – 2011 period in the Monroe County, WI area, which is 3.5 percent of economic area employment. The aggregate economic impact of all recommended actions on these economic regions of influence was considered and is at Appendix B of Volume I.

Community Infrastructure Assessment

A review of community infrastructure attributes revealed no significant issues regarding the ability of the infrastructure of the communities to support missions, forces, and personnel. When moving activities from Fort McCoy to Fort Knox, five improved (Child Care, Cost of Living, Education, Population Center and Transportation) and one (Employment) was not as robust. When moving from Fort Knox to Fort Benning, the following local area capabilities improved: Employment, Population Center, and Transportation; and the following local area capabilities are not as robust: Cost

of Living, Education, and Safety. There are no known community infrastructure impediments to implementation of all recommendations affecting the installations in this recommendation.

Environmental Impact

Tribal consultations may be necessary at Fort Knox and Fort Benning. An Air Conformity Analysis and New Source Review will be required at Fort Benning. Noise analysis and monitoring is required at Fort Knox and Fort Benning to determine the extent of new noise impacts. Additional operations may impact TES at Fort Benning, leading to additional restrictions on operations. Fort Knox range is located over the recharge zone of a sole source aquifer, which may result in future regulatory limitations on training activities. Significant mitigation measures to limit releases may be required to reduce impacts to water quality and achieve USEPA water quality standards at Fort Benning. This recommendation has no impact on dredging; land use constraints or sensitive resource areas; marine mammals, resources, or sanctuaries; waste management; or wetlands. This recommendation will require spending approximately $1.3M for environmental compliance costs. These costs were included in the payback calculation. This recommendation does not otherwise impact the costs of environmental restoration, waste management, and environmental compliance activities. The aggregate environmental impact of all recommended BRAC actions affecting the installations in this recommendation has been reviewed. There are no known environmental impediments to implementation of this recommendation.

Fort Bragg, NC

Recommendation

Realign Fort Bragg, NC, by relocating the 7th Special Forces Group (SFG) to Eglin AFB, FL, and by activating the 4th Brigade Combat Team (BCT), 82d Airborne Division and relocating European-based forces to Fort Bragg, NC.

Justification

This recommendation co-locates Army Special Operation Forces with Air Force Special Operations Forces at Eglin AFB, activates the 4th BCT of the 82nd Airborne Division and relocates Combat Service Support units to Fort Bragg from Europe to support the Army modular force transformation. This realignment and activation of forces enhances military value and

training capabilities by locating Special Operations Forces (SOF) in locations that best support Joint specialized training needs, and by creating needed space for the additional brigade at Fort Bragg. This recommendation is consistent with and supports the Army's Force Structure Plan submitted with the FY06 budget, and provides the necessary capacity and capability, including surge, to support the units affected by this action. This recommendation never pays back. However, the benefits of enhancing Joint training opportunities coupled with the positive impact of freeing up needed training space and reducing cost of the new BCT by approximately $54-$148M (with family housing) at Fort Bragg for the Army's Modular Force transformation, justify the additional costs to the Department.

Payback

The total estimated one-time cost to the DoD to implement this recommendation is $334.8M. The net of all costs and savings to the Department during the implementation period is a savings of $446.1M. Annual recurring costs to the Department after implementation is $23.8M, with no payback expected. The net present value of the costs and savings to the Department over 20 years is a cost of $639.2M.

Economic Impact on Communities

This recommendation will not result in any job reductions (direct or indirect) over the 2006-2011 period in the Fayetteville, NC and Fort Walton Beach- Crestview-Destin, FL, metropolitan statistical areas. The aggregate economic impact of all recommended actions on this economic region of influence was considered and is at Appendix B of Volume I.

Community Infrastructure Assessment

A review of community attributes revealed no significant issues regarding the ability of the local community's infrastructure to support missions, forces, and personnel. Of the 10 attributes evaluated (Child Care, Cost of Living, Education, Employment, Housing, Medical Health, Population Center, Safety, Transportation, and Utilities) two levels of support declined (Cost of Living, Education) when moving activities from Fort Bragg to Eglin AFB. There are no known community infrastructure impediments to implementation of all recommendations affecting the installations in this recommendation.

Environmental Impact

This recommendation may result in operational restrictions to protect cultural or archeological resources at Eglin AFB and Fort Bragg. Tribal consultations may also be required at both locations. Operations are currently restricted by electromagnetic radiation and/or emissions and additional operations/training may result in operational restrictions at Eglin AFB. Further analysis may be necessary to determine the extent of new noise impacts at Eglin and Bragg. Additional waste production at Eglin may necessitate modifications of hazardous waste program. Increased water demand at Fort Bragg may lead to further controls and restrictions and water infrastructure may need upgrades due to incoming population. Additional operations at Eglin may impact wetlands, resulting in operational restrictions. An evaluation of operational restrictions for jurisdictional wetlands will likely have to be conducted at Fort Bragg.

Added operations may impact threatened and endangered species at Fort Bragg and result in further operational and training restrictions. This recommendation has no impact on air quality; dredging; land use constraints or sensitive resource areas; or marine mammals, resources, or sanctuaries. This recommendation will require spending approximately $1.0M for environmental compliance costs. These costs were included in the payback calculation. This recommendation does not otherwise impact the costs of environmental restoration, waste management, and environmental compliance activities. The aggregate environmental impact of all recommended BRAC actions affecting the installations in this recommendation has been reviewed. There are no known environmental impediments to implementation of this recommendation.

Appendix F: Land Use Modeling

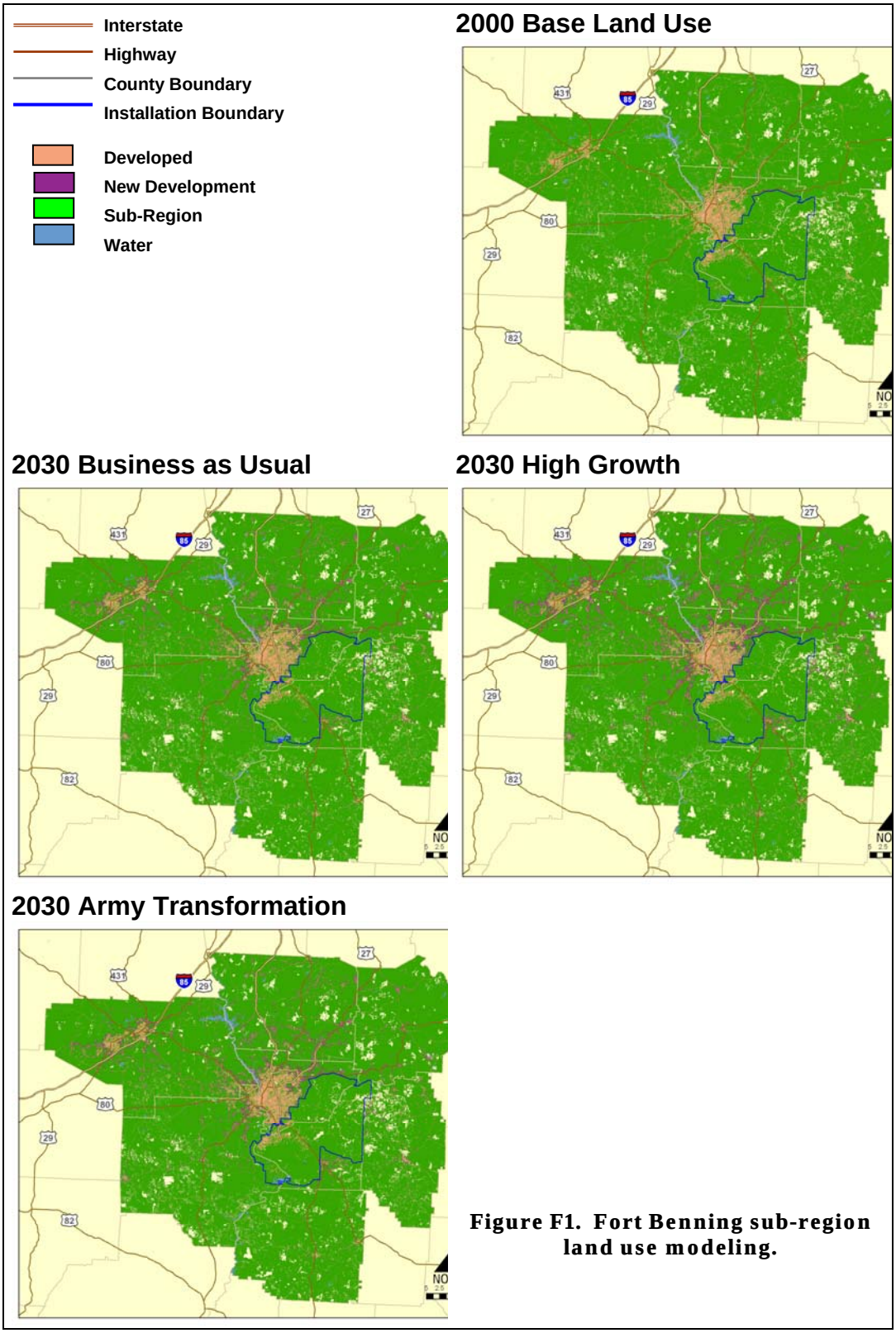
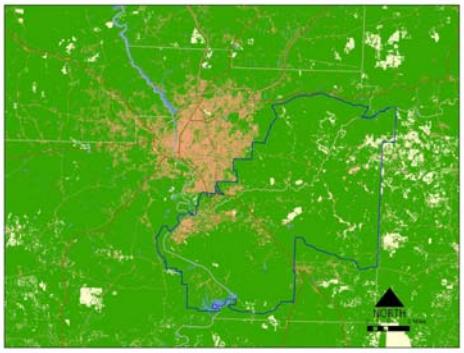
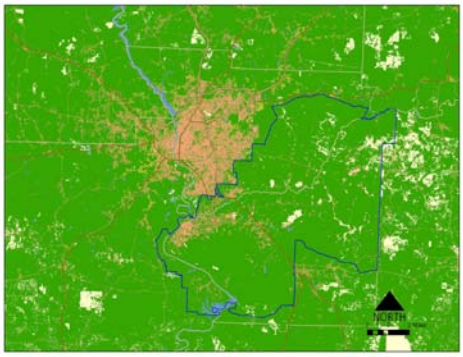
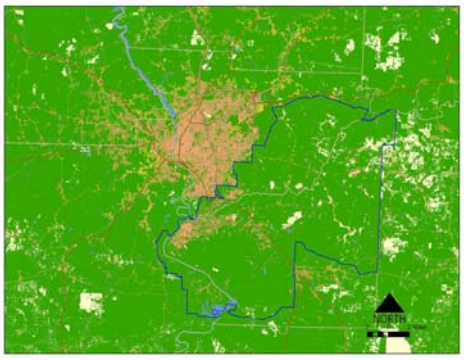
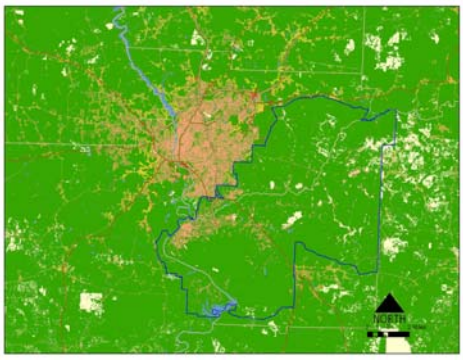


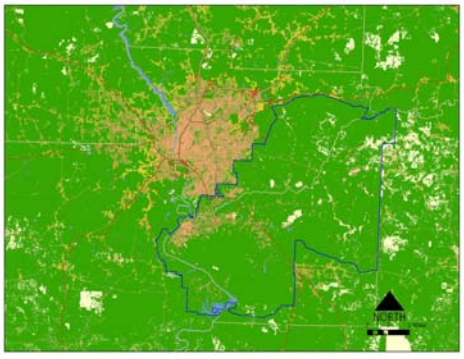
Figure F1. Fort Benning sub-region land use modeling.

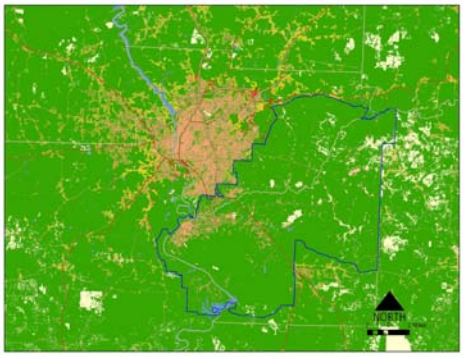












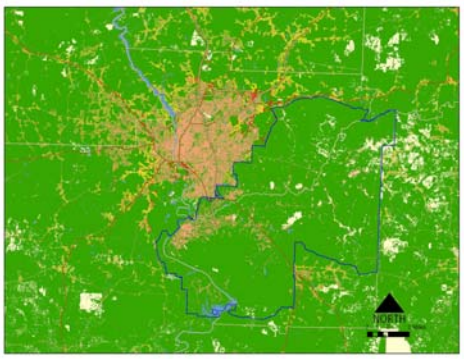


Figure F2. Fort Benning sub-region zoom business as usual.

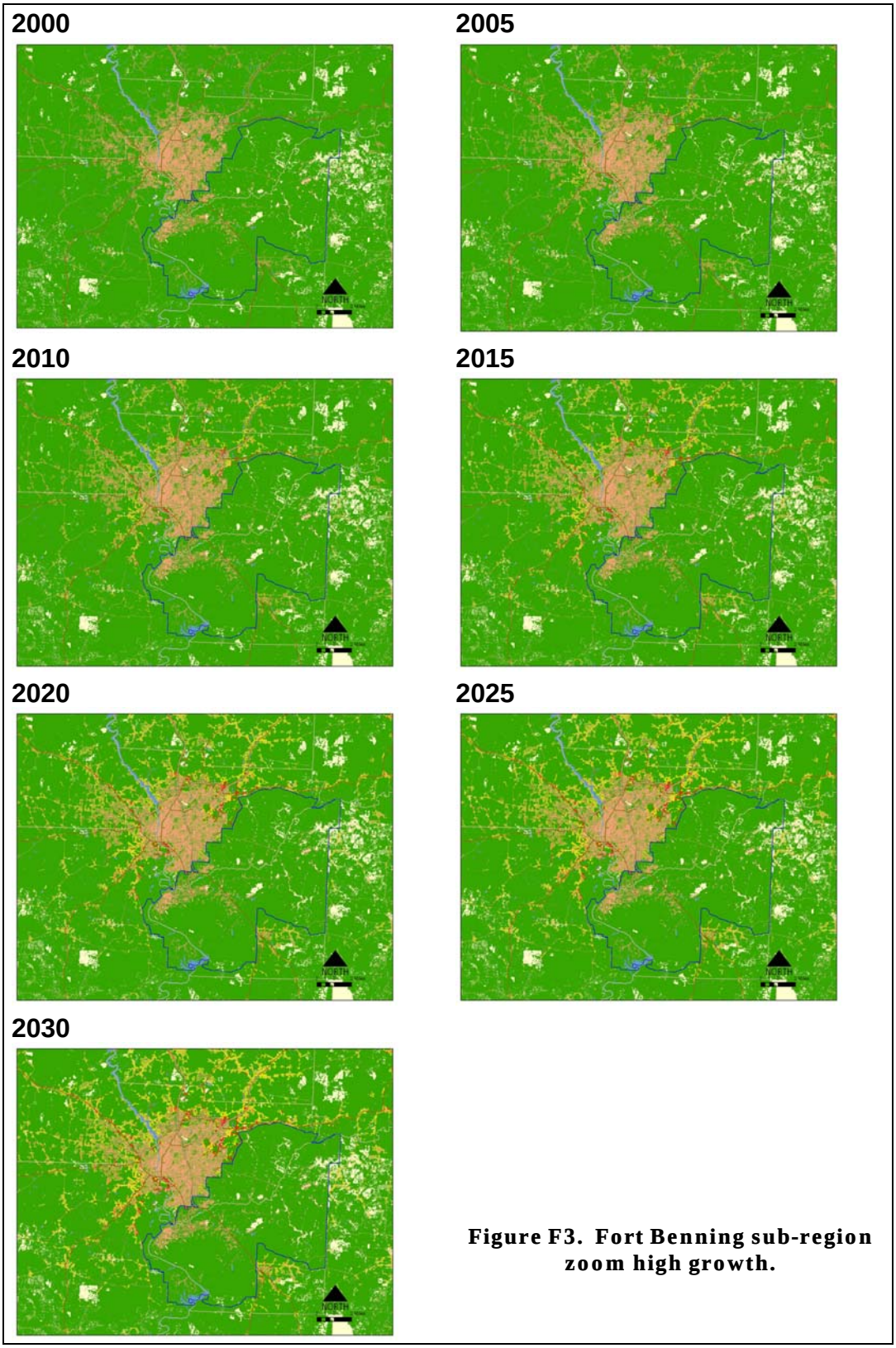


Figure F3. Fort Benning sub-region zoom high growth.

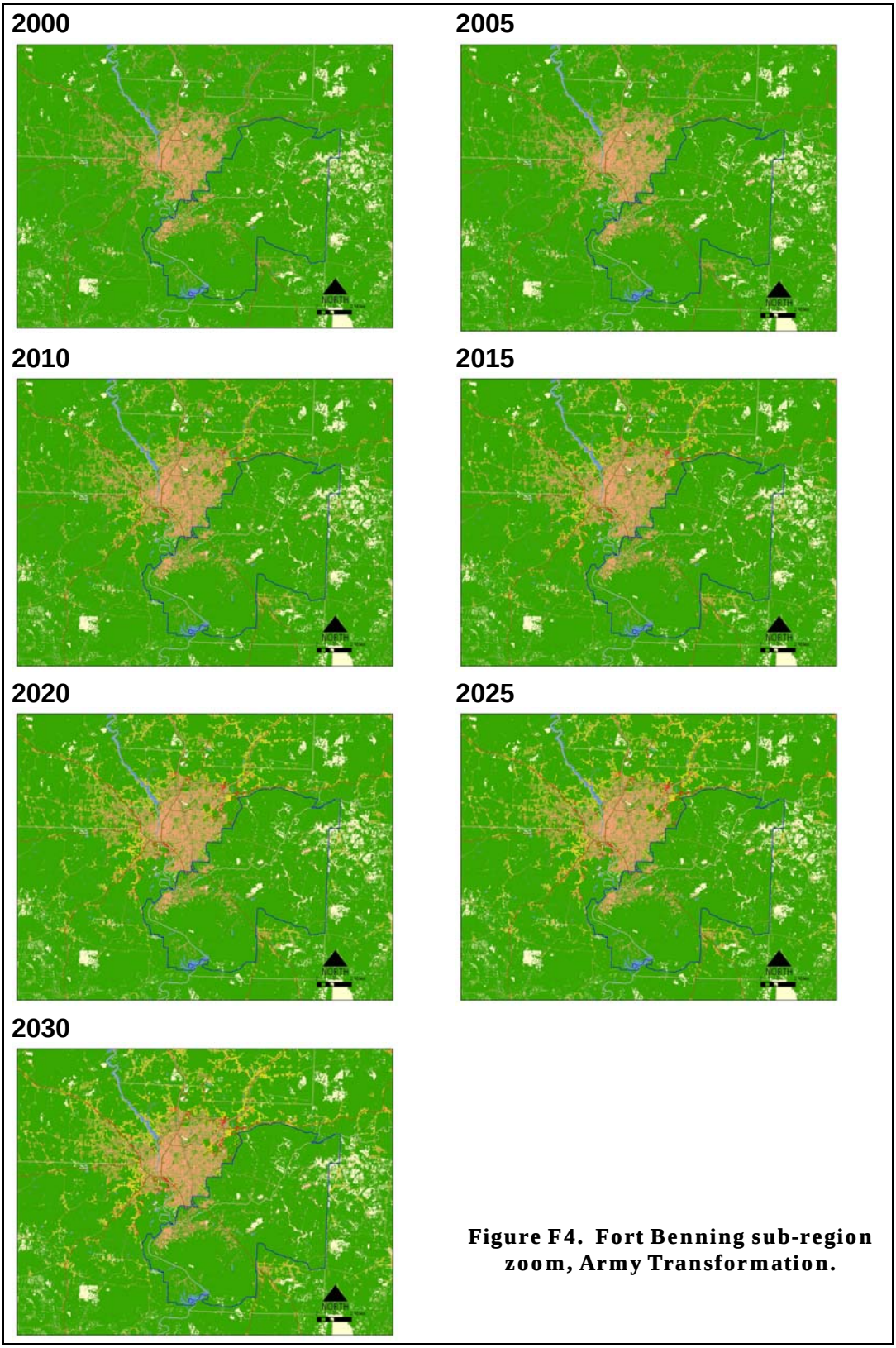


Figure F4. Fort Benning sub-region zoom, Army Transformation.

Table F1. Fort Benning land use change by county.

	Landcover Acres			
	2000	2030 Business as Usual	2030 High Growth	2030 Army Transformation
LEE COUNTY				
Residential	12,833	25,280	34,870	27,151
Commercial/Industrial	7,011	9,477	11,750	10,042
Agriculture	50,517	46,792	43,677	46,167
Forest	307,102	295,928	287,188	294,117
TALBOT COUNTY				
Residential	1,734	4,739	7,592	5,260
Commercial/Industrial	560	910	1,232	978
Agriculture	15,852	15,099	14,332	14,951
Forest	217,479	214,891	212,502	214,457
STEWART COUNTY				
Residential	1,934	2,734	3,919	2,927
Commercial/Industrial	839	884	978	902
Agriculture	29,363	29,160	28,850	29,114
Forest	239,205	238,579	237,633	238,418
MUSCOGEE COUNTY				
Residential	17,442	23,355	26,616	23,973
Commercial/Industrial	11,544	13,660	15,166	14,034
Agriculture	5,635	4,514	3,962	4,410
Forest	99,447	92,535	88,318	91,644
MARION COUNTY				
Residential	3,188	5,601	8,263	6,017
Commercial/Industrial	934	1,044	1,199	1,077
Agriculture	29,495	28,951	28,214	28,846
Forest	175,593	173,721	171,740	173,394
HARRIS COUNTY				
Residential	6,363	16,727	24,745	18,279
Commercial/Industrial	1,071	1,466	1,978	1,596
Agriculture	23,142	20,699	18,987	20,331
Forest	251,112	242,832	236,035	241,521
CHATTAHOOCHEE COUNTY				
Residential	3,150	4,361	5,371	4,565
Commercial/Industrial	4,979	5,079	5,215	5,114
Agriculture	2,267	2,191	2,116	2,175
Forest	141,868	140,645	139,588	140,426
RUSSELL COUNTY				
Residential	7,283	12,836	17,230	13,675
Commercial/Industrial	4,085	5,267	6,259	5,513
Agriculture	49,038	47,820	46,582	47,577
Forest	318,954	313,477	309,369	312,643
TOTAL				
Residential	53,927	95,632	128607.264	101845.83
Commercial/Industrial	31,022	37,787	43777.58	39255.26
Agriculture	205,311	195,227	186719.538	193571.568
Forest	1,750,761	1,712,607	1682372.61	1706619.894

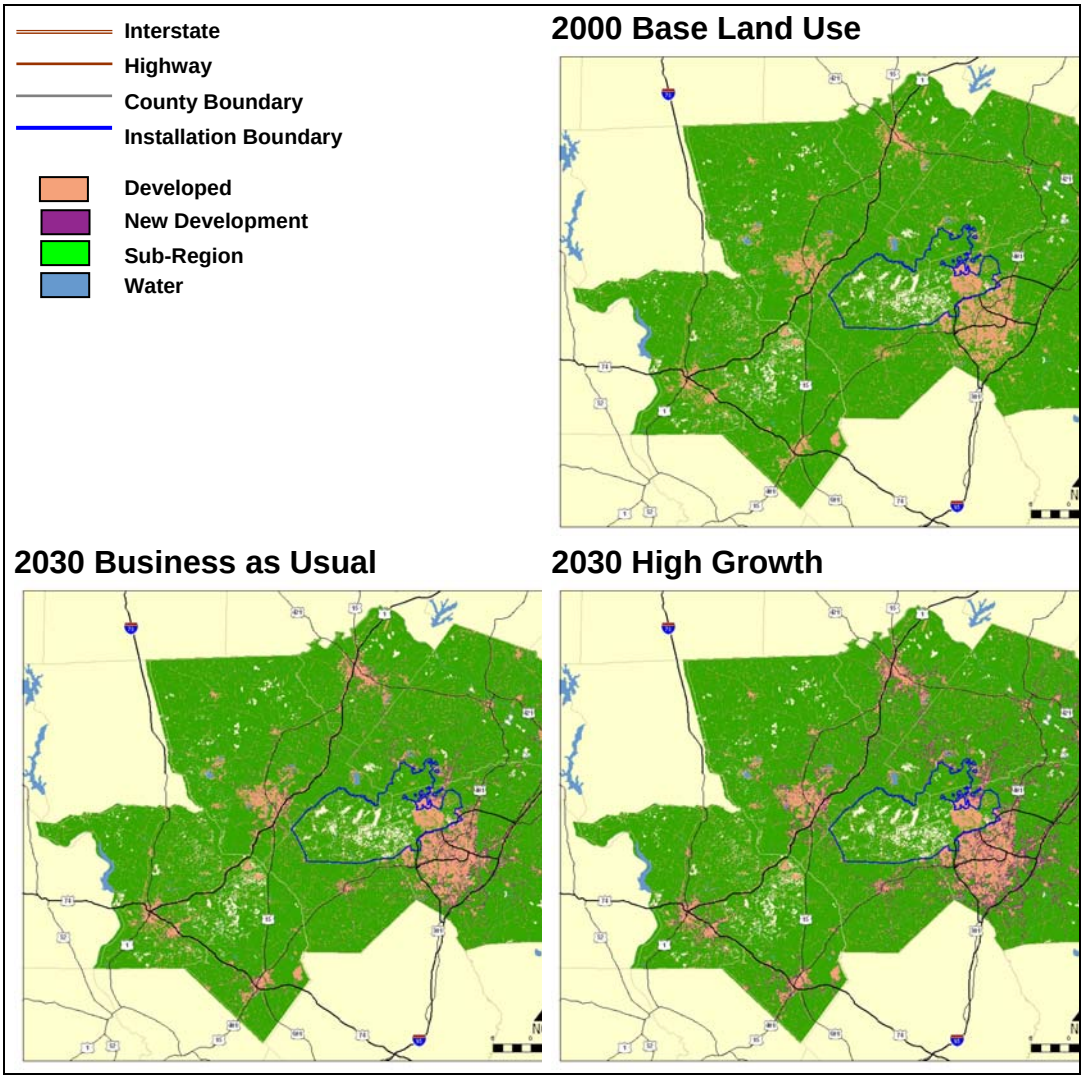


Figure F5. Fort Bragg sub-region land use modeling.

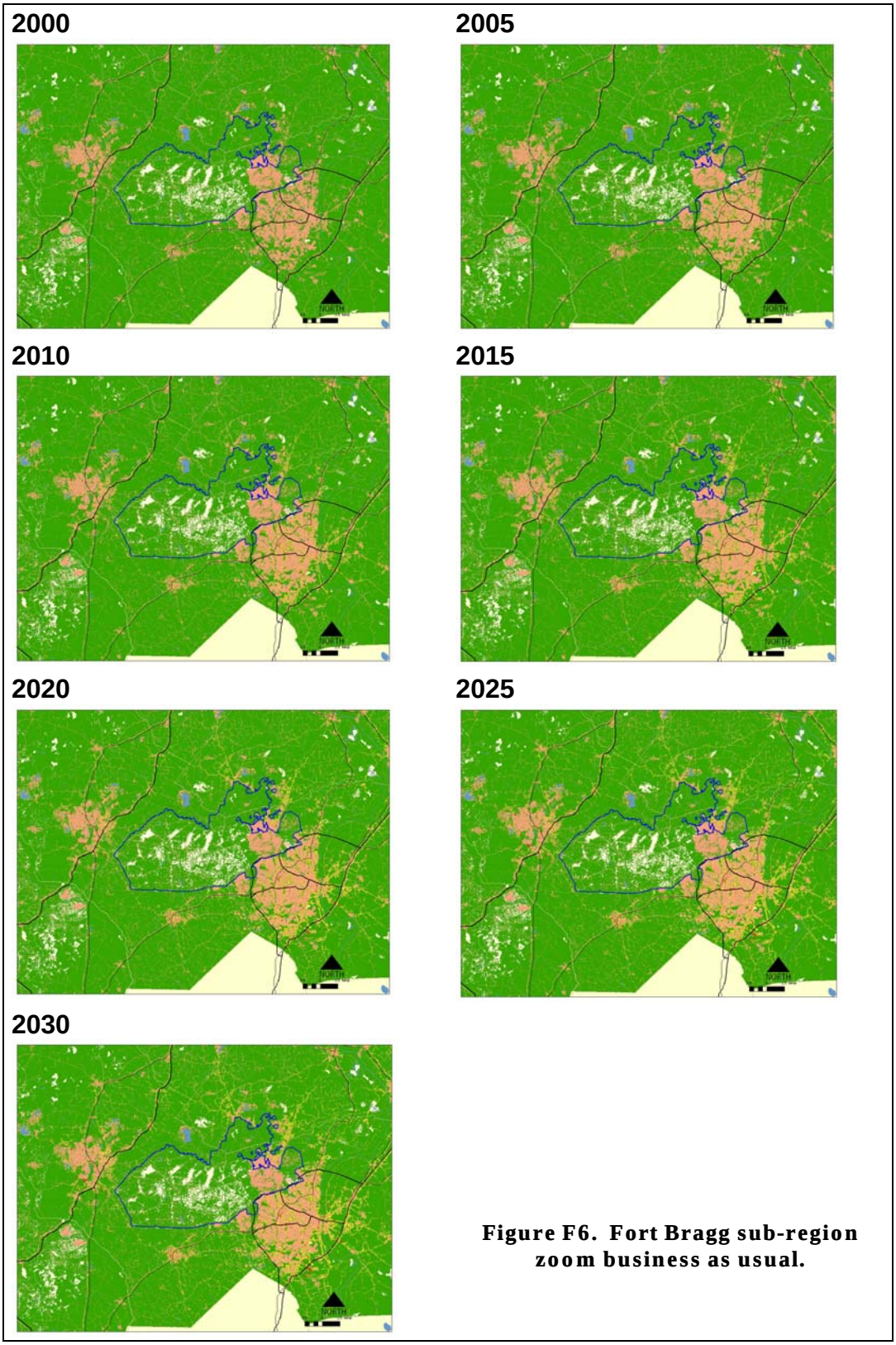
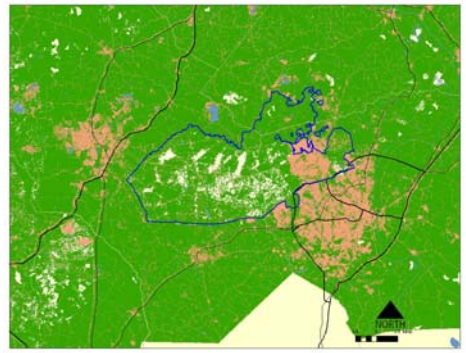
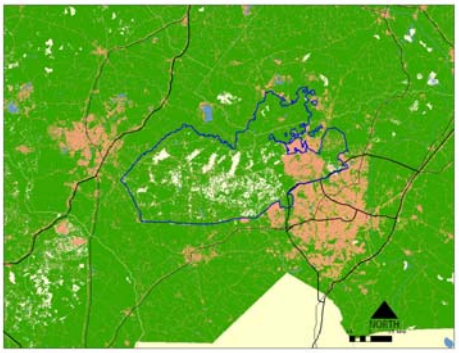
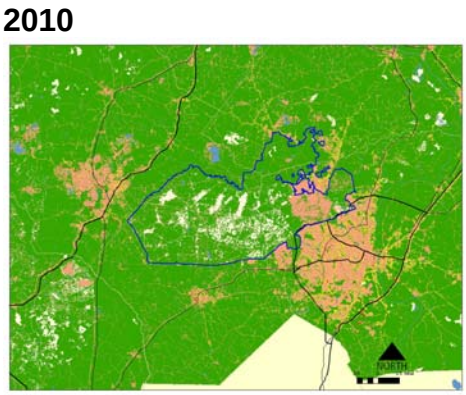
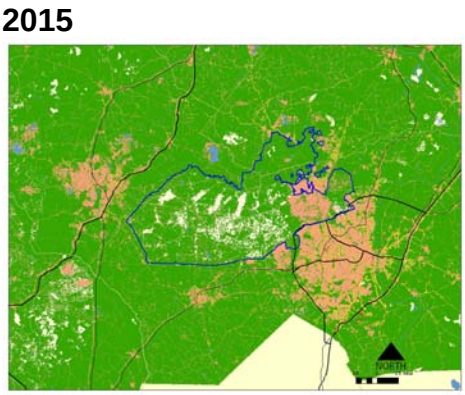


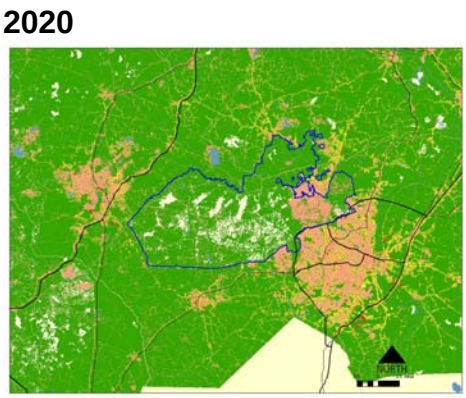
Figure F6. Fort Bragg sub-region zoom business as usual.

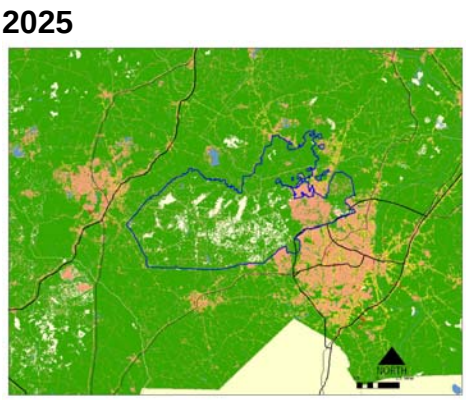












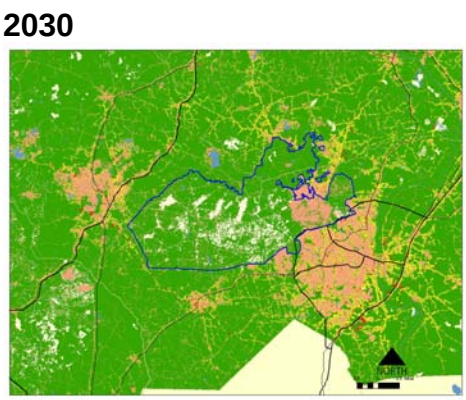


Figure F7. Fort Bragg sub-region zoom high growth.

Table F2. Fort Bragg land use change by county.

	Landcover Acres		
	2000	2030 Business as Usual	2030 High Growth
Lee County			
Residential	6,596	10,054	14,426
Commercial/Industrial	546	885	1,129
Agriculture	22,575	21,487	20,064
Forest	126,150	123,458	120,292
Harnett County			
Residential	13,389	24,951	38,464
Commercial/Industrial	355	737	1,306
Agriculture	108,900	103,267	96,324
Forest	247,263	241,025	233,964
Moore County			
Residential	11,179	16,443	23,668
Commercial/Industrial	482	918	1,315
Agriculture	53,533	52,283	50,462
Forest	370,994	366,564	360,792
Cumberland County			
Residential	44,263	68,193	84,719
Commercial/Industrial	3,326	4,769	6,061
Agriculture	96,184	87,328	79,874
Forest	270,450	254,082	243,808
Hoke County			
Residential	3,805	6,660	10,604
Commercial/Industrial	117	271	487
Agriculture	61,240	59,734	57,544
Forest	162,035	160,538	158,574
Richmond County			
Residential	8,479	10,836	14,293
Commercial/Industrial	775	1,030	1,295
Agriculture	38,948	38,268	37,275
Forest	239,438	237,558	234,914
Scotland County			
Residential	5,507	8,013	10,809
Commercial/Industrial	317	609	891
Agriculture	57,882	56,494	54,841
Forest	122,530	121,124	119,705
Total			
Residential	93,218	145,149	196984.374
Commercial/Industrial	5,918	9,220	12484.006
Agriculture	439,262	418,861	396384.552
Forest	1,538,861	1,504,348	1472050.032

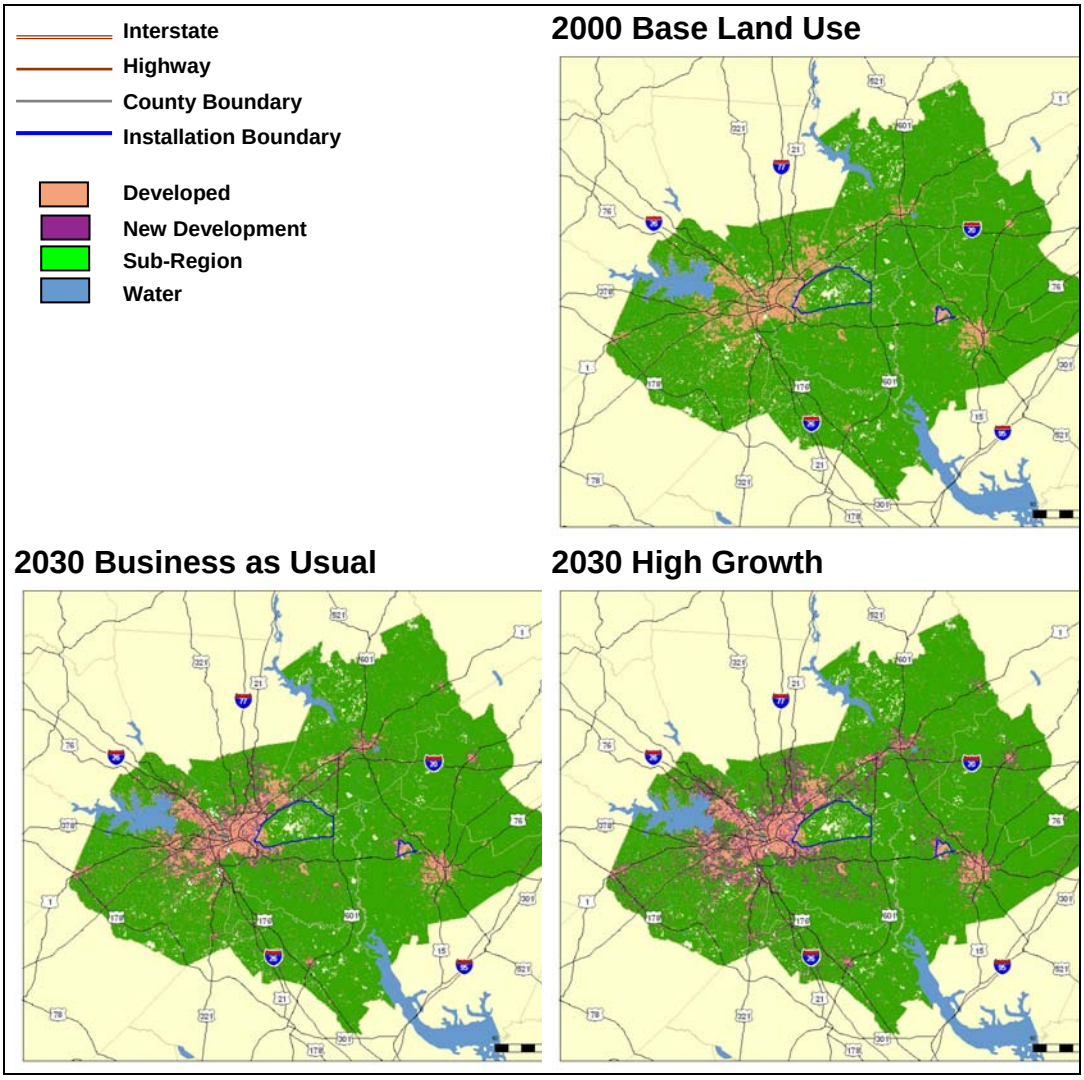


Figure F8. Fort Jackson sub-region land use modeling.

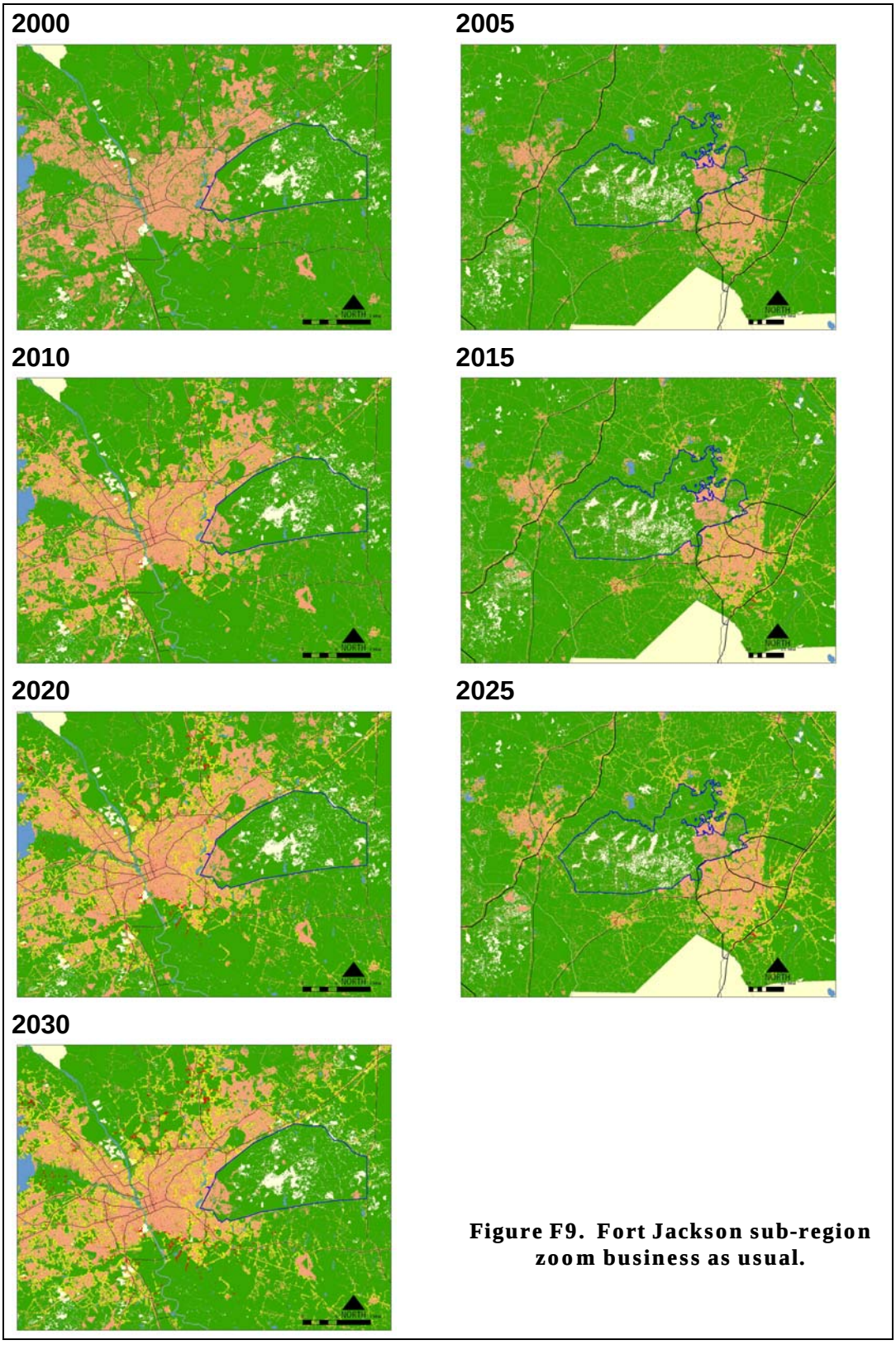


Figure F9. Fort Jackson sub-region zoom business as usual.

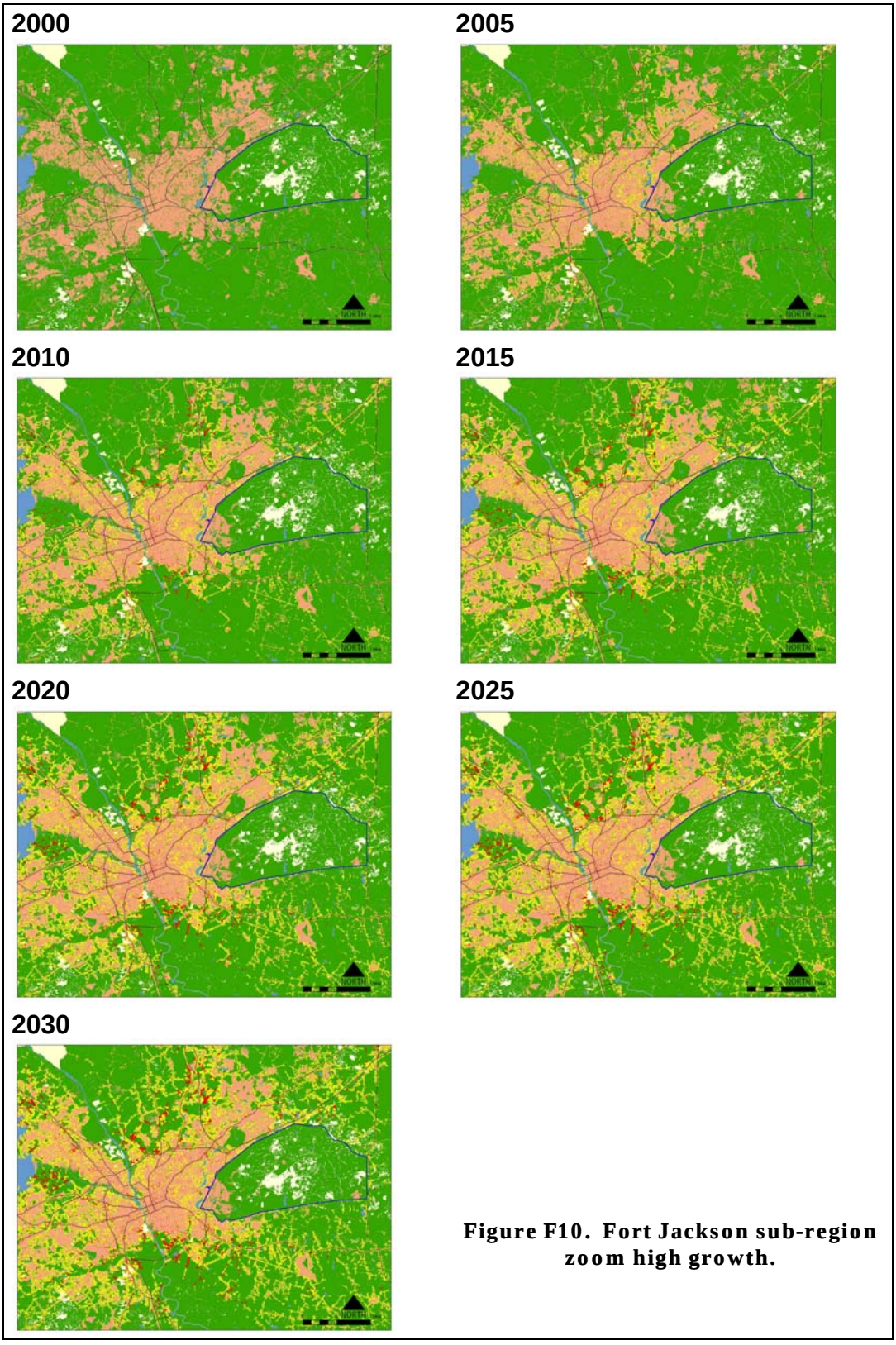


Figure F10. Fort Jackson sub-region zoom high growth.

Table F3. Fort Jackson land use change by county.

	Landcover Acres		
	2000	2030 Business as Usual	2030 High Growth
LEE COUNTY			
Residential	1,621	3,708	8,081
Commercial/Industrial	73	243	571
Agriculture	134,079	132,212	128,416
Forest	123,844	123,457	122,573
SUMTER COUNTY			
Residential	8,481	15,084	25,221
Commercial/Industrial	561	703	869
Agriculture	154,114	149,998	143,361
Forest	265,747	263,131	259,507
RICHLAND COUNTY			
Residential	34,676	67,536	91,370
Commercial/Industrial	3,543	7,394	10,939
Agriculture	70,324	57,810	49,517
Forest	360,978	337,106	318,332
LEXINGTON COUNTY			
Residential	26,407	54,064	80,604
Commercial/Industrial	2,081	4,168	5,982
Agriculture	111,217	99,964	89,785
Forest	294,935	277,051	259,516
KERSHAW COUNTY			
Residential	6,327	15,822	27,352
Commercial/Industrial	308	778	1,542
Agriculture	100,092	95,186	89,823
Forest	341,123	336,294	329,697
CALHOUN COUNTY			
Residential	1,597	4,705	10,000
Commercial/Industrial	36	132	300
Agriculture	75,364	74,047	71,937
Forest	159,506	157,724	154,572
TOTAL			
Residential	79,108	160,919	242629.572
Commercial/Industrial	6,601	13,418	20203.04
Agriculture	645,190	609,218	572838.81
Forest	1,546,133	1,494,763	1444196.136

Appendix G: Air Outcomes

The outcome analysis of air emissions provides a projection of air pollution emissions based on the modeled growth and development of the study areas. The goal in developing emission projections is to account for one of the important variables that affect the environment in future years. Emission projections provide a basis for developing intervention and control strategies, conducting attainment analyses, and tracking progress towards meeting air quality standards. Emission projections are a function of change in activity (growth or decline) combined with changes in the emission rate or controls applicable to the source. The projections of air emissions are based on the projected energy consumption in the study areas. The energy projections are based on land-use change resulting from the forecasts of residential and commercial/industrial growth, population growth, changes in land use patterns, and transportation growth.

Except for mercury emissions from power plants, the model assumes no changes in the emission rates of sources due to such things as technological advances, environmental regulations, age or deterioration, how the source is operated, changes in the electrical grid, and fuel formulations. Future year emissions may also be affected by fuel switching, fuel efficiency improvements, improvements in performance due to economic influences, or any occurrence that alters the emission producing process. Programs other than those aimed at reducing the emissions of the criteria pollutants of interest may affect the future year emissions. These may include energy efficiency programs, pollution prevention programs, and greenhouse gas or global warming initiatives. These are all possible interventions to reduce future impacts and are not currently modeled in this part of the SSA pilot study.

Fort Benning Region Emissions

Baseline emissions for the three county area around Fort Benning were taken from the Fall Line Air Quality Study (Unal 2003). Table G1 lists daily emission rates for several pollutants for the base year 2001. These were annualized and used as the baseline for the impact modeling on a limited three-county basis. this small model did not include the impact of electrical use since the three counties had no significant fossil fuel power plants. The Fall Line Air Quality Study was based solely on local sources.

Table G1. Emissions in the Fort Benning region.

Air Pollutant (lbs/day)	Chattahoochee	Harris	Muscogee	3 County Total
VOC	3,452	10,192	691	14,335
Nox	3,061	14,491	344	17,896
CO	11,860	60,469	2,705	75,034
SO2	180	377	60	617
PM10	3,922	21,446	236	25,604

Energy usage factors for the growth projected by LEAM™ were based on the LEAM™ sub-model for Sustainability (Fournier 2003). The factors in the model were updated based on census region and current U.S. Department of Energy data on building consumption patterns for both residential (EIA 2001) and commercial buildings (EIA 2003).

The air pollution sub-model calculates air pollution due to fossil fuel combustion. Values are provided for natural gas, fuel oil, coal, and gasoline. This model includes generation of carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_x, which is the sum of NO, NO_2 and other oxides of nitrogen), total particulates (sum of PM10 and PM2.5), smaller particulates (PM10), volatile organic compounds (VOC), and mercury (Hg). These values were obtained from the Cleaner and Greener Program Emission Factors guide for electricity (Leonardo Academy, Inc 2004), from USEPA AP-42 manuals for external combustion of the fossil fuels and wood, and from Anderson and Herendeen (Herendeen 1998) for automotive fuel. For electricity, the state level fossil fuel based emission factors for Georgia were used, since no nuclear plants are currently under construction, all are fully base-loaded, and all new electrical plants have been fossil based. Table G2 lists the pollutant emission factors used in the model for the state of Georgia.

Table G2. Emission factors for Georgia.

Pollutant	Electricity lb/MBtu	Nat Gas lb/MBtu	LPG lb/MBtu	Wood lb/MBtu	Gasoline lb/MBtu	Dist Oil lb/MBtu
SO_2	3.62496	0.00059	0.00059	0.025	3.4/454	1.014
NOx	1.314	0.137	0.149	0.175	0.4/454	0.129
CO	0.06065	0.034	0.02021	14.425	3.4/454	0.03571
CO_2	602.989	115	139.18	240	190	159.29
Tot Part	0.097275	0.00186	0.00426	1.912	NA	0.00286
PM_{10}	.0659244	0.00186	0	1.912	NA	0
VOC	0.007325	0.00539	0.00532	0	NA	0.00397
Hg	0.000108	0	0	0	0	0

Table G3 lists the results of emissions growth based on the three-county model for automobiles. The baseline year is 2001. Emissions growth was modeled based on the developed acreage change through the year 2030. The LEAM™ model projected a growth of about 27 percent in commercial/industrial property and a growth of about 55 percent in households. Emissions were based on projected energy consumption.

Table G3. Fort Benning three-county mobile emissions.

Year	2000	2030
Mobile Sources (lbs/day)	Tons/Year	Tons/Year
VOC	5,246	7,504
Nox	5,376	7,690
CO	36,350	51,997
SO2	288	412
PM10	254	363

Table G4 lists the emissions growth due to increasing fossil energy use and other emissions except for electrical consumption and motor fuels. The growth is based on the expected increase in number of households and commercial traffic.

Table G4. Fort Benning 3-county non-mobile emissions.

Year	2000	2030
Non-Mobile Sources (lbs/day)	Tons/Year	Tons/Year
VOC	9,859	14,958
Nox	4,103	6,225
CO	26,211	39,768
SO2	902	1,368
PM10	8,691	13,186

Table G5 lists the generalized emission profile for the entire region around Fort Benning through 2030. The emissions are based on the full analysis including energy demands from residential, commercial, and industrial buildings along with the projected vehicle usage by residents. As noted earlier, there are no major power plants in the area of Fort Benning, but the emissions from the power sector are included to show the overall impact of the expected growth in the region. Emissions are projected to grow about 33 to 38 percent depending on the pollutant. The model predicts carbon dioxide emissions will grow by about 5 million tons per year as a result of increased energy usage in the area. Other significant pollutants are oxides of sulfur and nitrogen, which are precursors to acid rain. The future scenario for emissions may well change in the future, but energy is at a crossroads right now and predictions of future fuel mix for utilities

changes yearly. Coal consumption may grow significantly in the future as maintaining the natural gas supply becomes more problematic.

Table G5. Emissions in the Fort Benning region.

Pollutant (tons)	Year						
	2000	2005	2010	2015	2020	2025	2030
SO2	67,562	68,868	77,516	81,735	85,022	87,447	89,558
NOx	19,894	20,479	23,375	24,859	25,964	26,746	27,404
CO	1,521	1,565	1,777	1,886	1,967	2,024	2,071
CO2	12,077,159	12,516,833	14,364,015	15,342,227	16,048,919	16,533,938	16,932,211
Particulates	2,595	2,646	2,974	3,135	3,260	3,352	3,432
Hg	1.47	1.51	1.73	1.84	1.92	1.98	2.03

Estimating the impact of growth in emissions on local ambient conditions is not possible. An airshed model is required to accomplish that effectively. It is important to note the three-county model for the region closest to Columbus in Georgia shows higher growth rates for emissions. Mobile sources are expected to grow by 43 percent and non-mobile sources by 52 percent due to the fact that the growth is higher in these counties, and higher growth should have some impact on the city's ambient attainment.

Fort Jackson Region Emissions

Table G6 shows the generalized emission profile for the entire region around Fort Jackson for the next 30 years. The emissions are based on the full analysis including energy demands from residential, commercial, and industrial buildings along with the projected vehicle usage by residents using emission factors for the state of South Carolina. There are major power plants in the area of Fort Jackson, so the emissions from the power sector will probably be impacted by the expected growth in the region and the requirement for more generating capacity. Emissions are projected to grow about 78 to 89 percent depending on the pollutant. The model predicts carbon dioxide emissions will grow by about 6.4 million tons per year as a result of increased energy usage in the area. Other significant pollutants are oxides of sulfur and nitrogen, which are precursors to acid rain. The scenario for emissions may well change in the future since energy is at a crossroads right now and predictions of the future fuel mix for utilities changes yearly. Coal consumption may grow significantly in the future as maintaining the natural gas supply becomes more problematic.

Table G6. Emissions in the Fort Jackson region.

Pollutant (tons)	Year						
	2000	2005	2010	2015	2020	2025	2030
SO2	31,316	36,704	43,199	47,998	51,784	54,522	56,840
NOx	10,371	12,311	14,630	16,315	17,621	18,541	19,298
CO	968	1,124	1,310	1,444	1,547	1,619	1,678
CO2	8,177,280	9,611,969	11,316,842	12,537,374	13,468,212	14,109,802	14,623,447
Particulates	1,688	1,976	2,320	2,569	2,762	2,897	3,009
Hg	0.66	0.79	0.94	1.05	1.14	1.20	1.25

Air Quality in the Fall Line Region

Major issues due to the South Atlantic region's population growth are the rapid increase in automobile usage and industrial development and their relation to air quality in the region. If current trends continue, air quality will continue to deteriorate. Air quality is closely tied to transportation and economic issues. This is because some of the primary sources for air pollution are industrial and vehicular. The majority of major metropolitan areas experience non-attainment periods regularly. The smaller metropolitan areas are also experiencing increasing problems with non-attainment. This reaches into the study cities in the SSA, specifically Columbus, GA, and Columbia, SC.

With the projected increase in population and continued reliance on the sprawl paradigm of auto-centric development patterns, air quality will continue to deteriorate and produce increasing non-attainment levels in the minor metro areas of the Fall Line.

Societal Costs of Combustion in the Fall Line Region

Societal costs refer to the indirect costs of using non-renewable energy sources. These include degradation of health, vegetation, and property due to air pollution from combustion of fossil fuels. These costs vary depending on the data source. This model incorporates the most recent data available based on emissions trading market rates, cleanup costs, and public utility commission decisions and policies. For some pollutants, including NOx and SOx, there is a well-established, liquid market and these market prices are the most available measure of the marginal price of emissions reductions or their societal value. Because the current market for emissions is driven by caps set by regulations, and not by calculations of actual costs such as the health effects of emissions, these market prices

underestimate the full health, property, and other costs associated with these air pollutants. This underestimate of actual costs by the market is particularly true for CO2, the primary gas causing anthropogenic (human-induced) climate change.

A report published in July 2002 for the United Nations (UN) Environmental Program's (UNEP) Finance Initiatives – Climate Change Working Group, *Climate Change and the Financial Services Industry*, warns of the significant financial risks posed by global warming. The report concludes that the "increasing frequency of severe climatic events, coupled with social trends, has the potential to stress insurers, reinsurers, and banks to the point of impaired viability or even insolvency." The UN estimates the potential cost of global warming at over $300 billion/year; insurance firms are becoming concerned about the possibility of lawsuits due to damage from human-induced global warming. A 2005 study by Harvard Medical School, Swiss Re, and the UN Development Program summarizes a broad range of large economic costs that continued climate change and global warming will impose, driven primarily by burning fossil fuels.

Costs for CO_2 are uncertain, although there is some consensus that early actions to reduce CO_2 emissions will see a cost of control of approximately $5 per ton of CO_2 (not per ton of carbon). In April 2005, the California Public Utility Commission adopted a net present value of $8 per ton CO_2, escalating at 5%/year, based on a cost stream of $5 per ton CO_2 in the near term, $12.50 per ton by 2008, and $17.50 per ton by 2013.*

Emissions have an economic impact because of their effect on public health. The precise value of this effect is difficult to determine, but some efforts have been made in areas where allowance trading does not exist. In other cases, estimates of the cost of control can be used. The impact model used the societal costs listed in Table G7.

The societal costs of the projected energy use in the three sub-regions of the Fall Line that were analyzed are show in Table G8. These costs are significant and are not currently internalized to the energy system or the price of energy. The societal costs fall on the general public and are not attributed to their true source. This leads to false feedback in an economy and suboptimal decision-making—when the signals are wrong, the decisions based on those signals will also be wrong.

* CPUC Decision 05-04-024, Conclusion of Law 7.

Table G7. Societal costs of fossil fuel combustion.

Pollutant	Cost ($/lb)	Source
NOx	$1.34	Average of NOx allowance prices for October 2004-September 2005 (NOx SIP Call region).
SO_2	$0.585	Average of SO_2 allowance prices for October 2004-September 2005 (National Acid Rain Program trading).
CO_2	$0.005 - $0.0175	California CPUC decision and rates.
PM_{10}	$1.00	"Damage function" – economic impact of PM_{10} pollution identified in a range of studies by researchers from LBNL
Hg	$55,000	28 January 2004 memorandum from USEPA Clean Air Markets division regarding cost of control; cost of $1.6 billion to reduce 2010 emissions by 14.6 tons

Table 8. Societal costs for energy usage in the fall line.

Societal Costs	2000	2030	Change
Fort Benning Region	$360,734,399	$537,596,285	$176,861,886
Fort Jacson Region	$181,433,402	$372,833,356	$191,399,954
Fort Bragg Region	$249,316,452	$374,177,931	$124,861,479

Appendix H: Water Outcomes

Table H1 lists data sources and their provided water resource indicators. Data from each source is available for extensive areas within the United States and is accessible to the general public.

Table H1. Water indicator data sources.

Source	Water-related Indicators
U.S. Environmental Protection Agency (USEPA) Draft State of the Environment Report (http://www.epa.gov/indicators/)	area, length, use standards, withdrawal, ecosystems, riparian land cover, atmospheric deposition, runoff, sedimentation, toxic releases, nutrients, wetlands, coastal waters, eutrophication, drinking water quality, recreation, and seafood consumption
USGS Concepts for National Assessment of Water Availability and Use (Circular 1223; http://pubs.water.usgs.gov/circ1223/)	surface and groundwater availability, flow, storage, withdrawal, consumption, losses, and water cycle inflow, outflow, and storage
Heinz Center State of the Nation's Ecosystems (http://www.heinzctr.org/ecosystems/index.htm)	area, length, chemical and physical conditions, biota, withdrawal, groundwater level, disease, and recreation
Roundtable on Sustainable Forestry (http://www.sustainableforests.net/)	area, flow, biological diversity, and quality
Sustainable Rangeland Roundtable (http://sustainablerangelands.cnr.colostate.edu/)	area, flow, erosion, biota, quality, channels, groundwater change, wetlands, and riparian extent and condition
Sustainable Minerals Roundtable (http://www.unr.edu/mines/smr)	quality compliance, problem sites, withdrawal, groundwater, use, consumption, discharge, recycling, reinjection, and evaporation
Sustainable Development in the U.S. (http://www.sdi.gov)	quality and supply vs. withdrawal

Table H2. USGS water model archive.

Archive	Models
USGS archives	Numerous USGS models, tools and archives such as BLTM, BRANCH, CAP, DAFLOW, DR3M, ECOM-si, FEQ, FESWMS-2DH, FOURPT, GenScn, HSPF, MMS, OTIS, PRMS, PHABSIM, SNTEMP, SSTEMP, SALMOD, SIAM, WINBRANCH, WSPRO, and the GIS Weasel.
USEPA archives	SWMM, SWRRB, P-ROUTE, QUAL2E, HSPF, MINTEQA2, CORMIX, PLUMES, QUAL2EU, SMPTOX3, WASP, BASINS, HSCTM2D, Visual Plumes, AQUATOX, EFDC, QUAL2K, OnSite calculators, and others.
USACE archives	Corps of Engineers archives: TABS, CH3D, HEC-RAS, HEC-HMS, CE-QUAL-W2, CE-QUAL-RIV1, BATHTUB ...
NWS archives	National Weather Service models: FLDWAV, DAMBRK, IFLOWS, HydroMet, NWSRFS, etc.
USDA archives	SWAT, KINEROS, AGWA, TR-55, WinTr-55, TR-20, WinTr-20, TR-19, SITES, WEPP, RUSLE2, PRISM, AGNPS, AGNPS 2001, REMM, and others.
FHWA and FTA archives: PC-TRANS | McTrans	Links to catalogs of hydraulic models distributed by the Federal Highway Administration and the Federal Transit Administration support centers
USBR Hydrologic Modeling Inventory	An effort by the U.S. Bureau of Reclamation to inventory useful hydrologic models.
Commercial archives	For-profit archives: DHI (MIKE11, MIKE21, MIKE3 ...), WL|Delft Hydraulics (DELFT3D, SOBEK, RIBASIM, DELFT-FLS, DELFT-WAVES ...), GEMSS, WMS, SMS, WQMAP, ChemMap, HydroMap, AquaDyn, CHI, WRCS, Dodson, BOSS, Pizer, Hydrocomp, AScI, Engenious, Riverware, Miduss, Haestad Methods, Civildesign, VDM, PC-Convey, HydroCAD, WARMF, XP Software, Eagle Point Software, LMNO, RiverTools, RMA, WinSLAMM, WaterCom Engineering, Wallingford Software, Vflo, and others.
Other archives	Other model archives and indexes, including PEST, ECOMSED, CAEDYM, DYRESM, DHSVM, TOPMODEL, POM, SCRUM, ROMS, SWAN, WATERSHEDSS, CRiSP1, SWMM, MODSIM-DSS, AVGWLF, and the Engineering Software Center.

Run-Off Models

One of the first water resource evaluation models was the “Rational Method.” Introduced in 1889, it is still widely used today despite heavy criticism for its simplistic approach. The Rational Method is an oversimplification, but is considered accurate enough for runoff estimation for a specific site design of relatively inexpensive structures where the consequences of failure are limited. The tool estimates the peak rate of runoff at any location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time of concentration (the time required for water to flow from the most remote point of the basin to the location being analyzed).

Since the development of the Rational Method, another popular run-off evaluation model is the Soil Conservation Service (SCS) curve number method (SCS CN)—developed in 1972 it is also known as the Hydrologic

Soil Cover Complex Method. Over the past 30 years, the SCS CN method has been used considerably by scientists and researchers because of its ability to integrate new understandings of runoff dynamics. The SCS CN method is a simple and efficient method for determining the approximate amount of runoff from a rainfall in a particular area. Although the method is designed for a single storm event, it can be scaled to find average annual runoff values. The amounts of inputs are simply rainfall amount and curve number. The curve number is based on the area's hydrologic soil group, land use, treatment, and hydrologic condition, the two former being of the greatest importance.

SCS CN equations are based on trends observed in data from collected sites. Thus, they are empirical equations instead of physically based equations—allowing for greater transferability and simplicity.

Given the SCS CN equations, researchers have generated a number of alternative versions of the model. Examples are SedSpec, TR_55, and L-THIA. SedSpec (Sediment and Erosion Control Planning, Design and Specification Information and Guidance Tool) was developed by the Army Corps of Engineers to analyze runoff and erosion problems by determining the peak rate of runoff from the area. The analysis provides information about different types of runoff and erosion control structures. SedSpec is best applied to a small site and is intended for use on a single storm event. Technical Release 55 (TR-55) was introduced by the SCS (currently known as the Natural Resource Conservation Service) in 1975 as an update to their original SCS CN method. The updates addressed growing concerns over urban sprawl and the land use change issues impacting hydrologic aspects such as flooding, stream degradation, erosion, and loss of groundwater supply. TR-55 is identical to another methodology called L-THIA (Long-Term Hydrologic Impact Assessment). L-THIA was introduced by Purdue University. Both TR-55 and L-THIA present simplified procedures for estimating runoff and peak discharges in small watersheds using the SCS CN model, yet they also repeat the method for each storm over a 30 year period and then report the average annual runoff value. L-THIA has subsequently developed as a GIS application—making it more desirable.

Run-off models are simplistic, transferable, and provide relatively accurate estimates of water quantity. Additionally, their equations have evolved to integrate water quality estimations.

Chemical Concentration Models

Another set of water resource models focuses on chemical concentrations instead of runoff to determine water quality or health within a region. The USGS used statistical regressions to predict presence of nitrate concentrations using manure, fertilizer, atmospheric deposition, soil type, depth to bedrock, depth to water table, population density, etc. By knowing the conditions likely to predict nitrates above drinking water standards, groundwater's vulnerability to degradation can be implied (Green 2003). The USGS determined the likelihood of high nitrate levels in groundwater for an entire country by monitoring nitrate levels at 1,280 sites across the United States. Another USGS project predicted concentrations of nitrogen, agricultural pesticides, and urban pesticides in groundwater in the Mid-Atlantic Coastal Plain using similar methodologies (Brooks 2003). The USEPA estimated sulfate, nitrate, and acidity in streams by using the percent agriculture, percent urban, and catchments size to determine surface water quality (Yuan 2003). The Wisconsin Lake Modeling Suite (WiLMS) is a free Windows computer model designed to evaluate the impact of phosphorus loading on lake and reservoir water quality. WiLMS contains an export coefficient-driven watershed loading module, 13 annualized empirical lake and reservoir response models coupled with trophic response evaluation routines, and uncertainty analysis. WiLMS is used to evaluate the impact of various land use and point source management alternatives on receiving water quality.

The use of spatial statistics to interpolate residual variation in water quality is a simplistic and transferable methodology. It is also comprehensive and accurate, yet only to the extent of water quality not quantity. With a continuing global trend of over pumped water sources, quantity plays a vital role in characterizing a water resource. For a complete picture of water health, chemical concentration models are best integrated with a quantity focused model.

Impervious Surface Models

The final set of water resource modeling uses impervious surface as the primary indicator. For many years, impervious surfaces have been recognized as an indicator of the intensity of the urban environment. With the increase in urban sprawl, impervious surfaces have also become a key issue in growth management and watershed planning due to their impact on habitat health. Increasing urbanization results in increased amounts of impervious surfaces—roads, parking lots, roof tops, and so on—and de-

creases the amount of forested lands, wetlands, and other forms of open space that absorb and clean stormwater in the natural system. Quite simply, impervious surfaces significantly change natural patterns of water movement, affecting river flows and the recharge of groundwater.

The important thing to know is the percentage of the watershed covered by impervious surfaces. Generally, research on rivers and estuaries confirms that when impervious surfaces cover more than 10 percent of a watershed, the rivers, creeks, and estuaries they surround become biologically degraded (Costal Sprawl) (Beach 2002). The National Oceanic and Atmospheric Administration (NOAA) defines less than 10 percent imperviousness as "protecting water resources," 10 to 25 percent imperviousness as "degrading water resources," and greater than 25 percent imperviousness as "impacted water resources." A 1-acre parking lot produces a runoff volume almost 16 times as large as the runoff volume produced by an undeveloped meadow (USEPA 2002).

NOAA Coastal Services Center and the University of Connecticut Nonpoint Education for Municipal Officials (NEMO) Program developed the Impervious Surface Analysis Tool (ISAT) to help managers and planners make a determination about the impact of impervious surface coverage on local water quality. ISAT applies impervious surface coefficients to remotely sensed land cover data to determine the total and the percentage of impervious surface area within specified polygons. ISAT can also be used to demonstrate the effects of land cover change on a watershed's imperviousness. The coefficients in ISAT were developed to be used with the NOAA Coastal Services Center's Coastal Change Analysis Program (C-CAP) land cover data, but can be modified for use with various types of land cover data or to match the land cover/land use practices within a specific geographic region.

USGS research indicates that if today's growth trends continue, many healthy watersheds will cross the impervious surface threshold over the next 25 years and the United States will experience sharp and irreversible declines in the health of our waters. The USGS has developed threat maps of developed land (Claggett 2003) for the entire United States. However simplistic and transferable an impervious surface methodology may be, only using impervious surface fails to incorporate additional contributing factors to water degradation. The Chesapeake Bay Program determined water quality based on percent of impervious surface along with proximity to water, erodable soil, slope, stream density, percent forested, and acid

neutralizing capacity (Todd 2003). The SEMP Ecosystem Characterization and Monitoring Initiative (ECMI) used a similar methodology for Fort Benning, GA with the purpose of describing a long-term baseline ecosystem monitoring plan. The main focus remained on landuse classifications and their impact on the ecosystem.

Shortfalls of any impervious surface models are that that they are short-term and incorporate no economic data. Impervious surface models are not comprehensive and thus are ideal to be incorporated with more localized methodologies.

L-THIA Methodology

The run-off model L-THIA was developed to provide a quick, accessible tool to use in assessing the long-term impacts of land use change. With its GIS integrations, L-THIA is most compatible with the land use change model LEAM™.

LEAM™ and L-THIA were coupled to model the long-term impacts of land-use transformation associated with urbanization on water quality. L-THIA as used in their study, uses LEAM™-generated land use maps as input. It integrates rainfall and impervious surface to determine stream quantity and quality. It also allows for integration with climate change scenarios to model plausible outcomes. L-THIA has been developed as a straightforward analysis tool that provides estimates of changes in runoff, recharge and nonpoint source pollution resulting from past or proposed land use changes. It gives long-term average annual runoff for a land use configuration based on actual long-term climate data for that area. By using many years of climate data in the analysis, L-THIA focuses on the average impact, rather than an extreme year or storm. L-THIA results do not predict what will happen in a specific year. As a quick and easy approach, L-THIA results are intended to provide insight into the relative hydrologic impacts of different land use scenarios. The results can be used to generate community awareness of potential long-term problems and to support physical planning aimed at minimizing disturbance of critical areas. It is an ideal tool to assist in the evaluation of potential effects of land use change and to identify the best location of a particular land use so as to have minimum impact on the natural environment of the area.

To simplify the process, there are three assumptions embedded in L-THIA: (1) no consideration of snowfall; (2) no influence of ground freezing; and (3) constant antecedent moisture conditions. Calculating the CN

values in L-THIA requires a hydrological soil group (HSG) map, a series of land-use maps, and a long-term daily precipitation data file. Besides the CN values, runoff depth, runoff volume and, above all, pollutant loading are calculated in a row. Loadings for 17 pollutants including total dust/dirt, suspended and dissolved particles, chemicals, and heavy metals can be calculated. Despite these advantages, L-THIA has some limitations. Grove et al. (1998) and Leitch and Harbor (1999) both compared the long-term runoff calculated by L-THIA with stream-flow monitoring data and found that L-THIA tended to underestimate, though the absolute values were consistent with measured data. Indeed, in the earliest report of L-THIA, Harbor (1994) emphasized that absolute predictions from L-THIA should not be considered very precise, that the method only provided insights into relative impacts of land-use patterns on surface runoff, and that L-THIA was not designed to predict levels of streamflow.

Table H3. Imperviousness coefficients.

Land Use Description	Impervious Surface Coefficient
Open Water	0
Residential	59.5
Commercial/Industrial/Transportation	59.5
Clear-cut sparse vegetation	14.9
Quarries, Strip Mines and Gravel Pits	72
Quarries, Strip Mines and Gravel Pits	72
Deciduous Forest	3.9
Evergreen Forest	3.9
Mixed Forest	3.9
Pasture, Hay	14.9
Row Crops	14.7
Urban Recreational Grasses	14.9
Woody Wetlands	22.1
Emergent Herbaceous Wetlands	0
Source: NOAA ISAT	

Table H4. Fort Bragg Imperviousness.

		Acres				
Land Use Description	Impervious Surface Coefficient	2000	2015 (25.6% Growth Rate)	2030 (25.6% Growth Rate)	2015 (89.5% Growth Rate)	2030 (89.5% Growth Rate)
Open Water	0	19,505	19,505	19,505	19,505	19,505
Residential	59.5	93,780	122,183	146,041	150,538	198,324
Commercial/Industrial/Transportation	59.5	5,991	7,809	9,337	9,623	12,670
Clear-cut sparse vegetation	14.9	5,120	4,999	4,914	4,886	4,751
Quarries, Strip Mines and Gravel Pits	72	4,073	3,974	3,903	3,891	3,759
Quarries, Strip Mines and Gravel Pits	72	58,494	58,416	58,316	58,320	58,107
Deciduous Forest	3.9	485,014	476,285	469,604	468,271	455,443
Evergreen Forest	3.9	491,296	485,002	479,689	478,882	468,428
Mixed Forest	3.9	255,638	251,402	248,263	247,640	241,478
Pasture, Hay	14.9	68,422	67,696	66,785	66,712	64,619
Row Crops	14.7	383,273	373,357	364,309	362,416	343,702
Urban Recreational Grasses	14.9	146,165	146,141	146,102	146,086	145,983
Woody Wetlands	22.1	192,003	192,003	192,003	192,003	192,003
Emergent Herbaceous Wetlands	0	3,427	3,427	3,427	3,427	3,427
Total Cells		2,212,201	2,212,201	2,212,201	2,212,201	2,212,201
Imperviousness		12.84	13.54	14.12	14.23	15.40

Table H5. Fort Jackson imperviousness.

		acres				
Land Use Description	Impervious Surface Coefficient	2000	2015 (28.3% Growth Rate)	2030 (28.3% Growth Rate)	2015 (99.1% Growth Rate)	2030 (99.1% Growth Rate)
Open Water	0	65,929	65,929	65,929	65,929	65,929
Residential	59.5	111,789	152,244	182,324	196,421	258,801
Commercial/Industrial/Transportation	59.5	6,661	10,773	13,540	14,884	20,387
Clear-cut sparse vegetation	14.9	3,152	2,374	2,193	2,057	1,822
Quarries, Strip Mines and Gravel Pits	72	6,119	5,736	5,503	5,407	5,046
Quarries, Strip Mines and Gravel Pits	72	46,561	46,232	45,831	45,641	44,676
Deciduous Forest	3.9	395,934	387,093	380,189	377,182	362,954
Evergreen Forest	3.9	468,379	454,892	445,976	442,343	424,963
Mixed Forest	3.9	244,589	237,263	232,371	230,269	220,663
Pasture, Hay	14.9	69,499	68,219	66,881	66,236	63,266
Row Crops	14.7	543,296	531,173	521,218	515,634	493,688
Urban Recreational Grasses	14.9	99,131	99,111	99,084	99,037	98,844
Woody Wetlands	22.1	330,618	330,618	330,618	330,618	330,618
Emergent Herbaceous Wetlands	0	5,208	5,208	5,208	5,208	5,208
Total Acres		2,396,866	2,396,866	2,396,866	2,396,866	2,396,866
Imperviousness		13.78	14.72	15.42	15.74	17.16

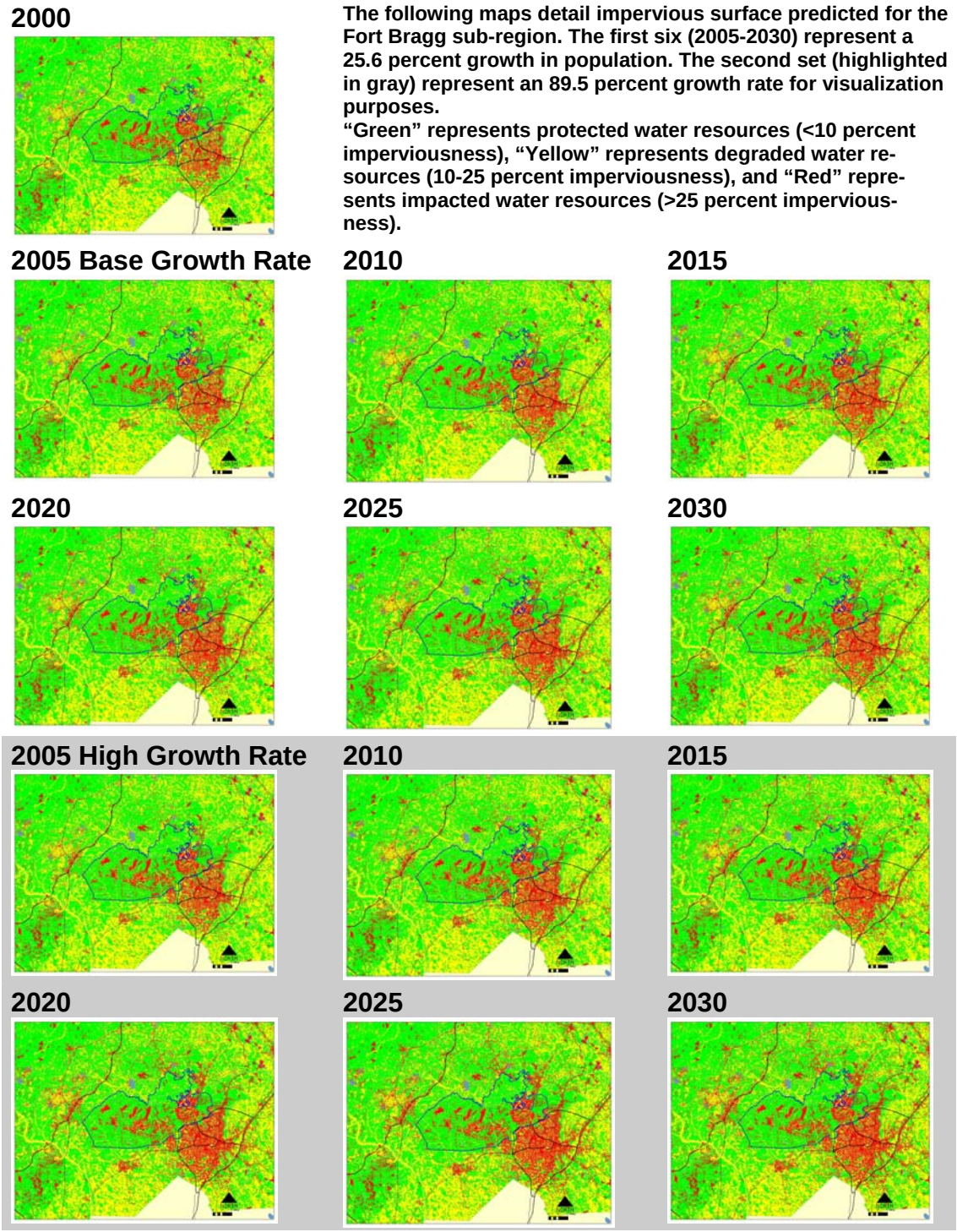
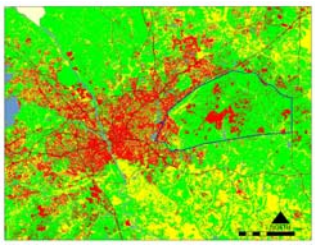


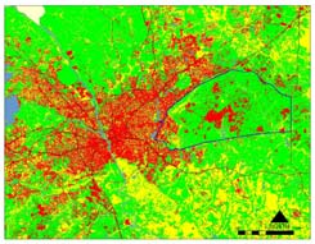
Figure H1. Impervious Surface Fort Bragg

2000

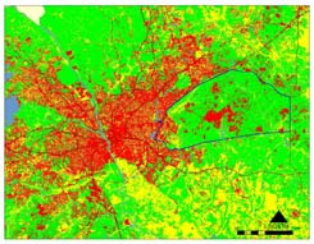


The following maps detail impervious surface predicted for the Fort Jackson sub-region. The first six (2005-2030) represent a 28.3 percent growth in population. The second set (highlighted in gray) represent a 99.1 percent growth rate for visualization purposes.
"Green" represents protected water resources (<10 percent imperviousness), "Yellow" represents degraded water resources (10-25 percent imperviousness), and "Red" represents impacted water resources (>25 percent imperviousness).

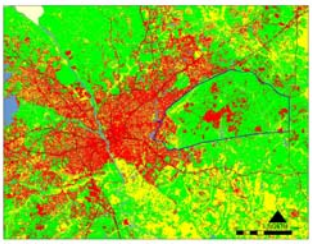
2005 Base Growth Rate



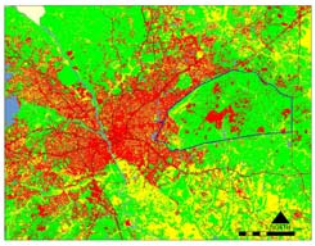
2010



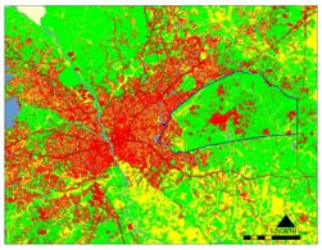
2015



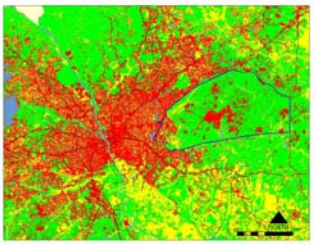
2020



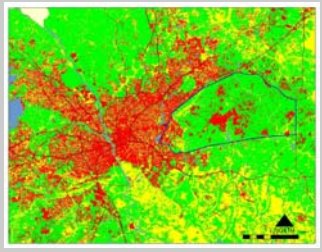
2025



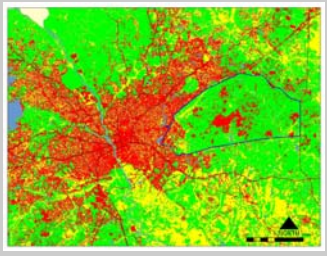
2030



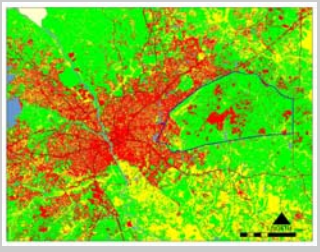
2005 High Growth Rate



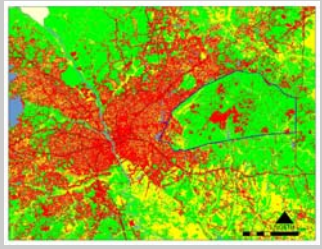
2010



2015



2020



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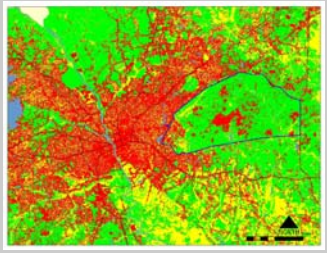


2030

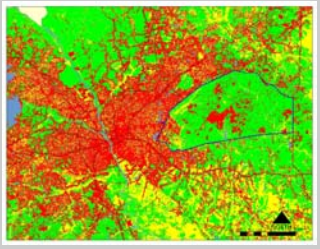


Figure H2. Impervious surface Fort Jackson.

Appendix I: Energy Gap Analyses

Energy Availability

DoD installations have about 2,600 electric, water, wastewater, and natural gas utility systems valued at about $50 billion (USGAO, 2005). Following years of under-funding, many military utility systems are not fully capable of supporting mission requirements or a quality workplace for Department personnel. Reliable utility services are essential to support our forces. In 1997, the DoD decided that utility privatization was the preferred method for improving utility systems. Congress then approved legislation to privatize utility systems at military installations under Title 10 U.S.C. 2688. By December 1998, the DoD outlined privatization guidelines through Defense Reform Initiative Directive No. 49.

Through the Utilities Privatization Program, the DoD transfers ownership, operations, and maintenance of the Government's utility system to free up resources (money and manpower); take advantage of available technology from the private sector; and allow the military to concentrate more on its core functions. Current policy directs the privatization of every government owned electric, water, wastewater, and natural gas utility system unless security or economic concerns require federal ownership.

Ninety-four systems have been privatized following the congressional legislation. This represents nearly $4 billion of infrastructure (USGAO, 2005). The Army has been particularly successful in using privatization to improve the safety and quality of utility services. As private industry continues to work closely with the DoD, significant progress is being made in the improvement of utility efficiency and costs.

Energy resources for Army installations are purchased from the general economy. Installations, in general, do not generate their own electrical power. Natural gas is purchased off the grid and petroleum products are centrally purchased through the Defense Fuels Supply Center (DFSC). Installations may or may not take part in larger buys for natural gas through DFSC programs. Attempts are underway to consolidate both electrical and natural gas purchases across several installations where states are deregulated.

Energy Conservation Policy

Reliable and affordable energy is essential to continued operations on DoD installations as well as sustaining local communities and the nation's economy, in general. Executive Order 13123 required that all DoD installations reduce energy use intensity (kBtu/sf) 30 percent by 2005 and 35 percent by 2010 using 1985 as a baseline. In addition, the Energy Policy Act (Public Law 109-58) was signed into law on August 8, 2005. EPAct 2005 requires DoD installations to reduce their energy consumption 2 percent per year from 2006 to 2015 for a total 20 percent reduction with a new baseline year of 2004. EPAct 2005 supersedes requirements of the Executive Order.

The communities of Fayetteville, North Carolina, and Columbus, Georgia, on the other hand, do not strive for specific energy reductions. The communities primarily consume electric power supplemented with natural gas for residential, commercial, and industrial uses and petroleum products for transportation—all of which are purchased and/or distributed by commercial businesses. Therefore, long-term goal setting and management is left to the interests of these organizations and is rarely addressed in community or regional master plans. It should be noted that for states to qualify for certain energy-related federal programs, they are required under EPAct 2005 to implement energy saving programs that will reduce energy consumption by 25 percent from 1992 to 2012. This is an extension of the program first introduced in EPAct 1992.

Fort Bragg/Fayetteville, NC

Carolina Power & Light Company (CP&L), a division of Progressive Energy, is the primary source of power for Fort Bragg and Fayetteville. North Carolina Natural Gas (NCNG), a part of Piedmont Natural Gas, is the primary supplier of natural gas. Fort Bragg privatized their distribution systems to Sandhills Utility Services LLC in 2003. Fayetteville Public Works continues to own and operate the primary electrical distribution system for the city and NCNG owns and operates the primary natural gas distribution system.

In 1997, Fort Bragg partnered with Honeywell in a 12-year Energy Savings Performance Contract (ESPC) to enhance reliability and lower energy costs. The ESPC undertook 23 major projects to reduce energy consumption and costs at Fort Bragg. Examples of these projects include improvements to the installation's natural gas distribution system, and upgrading

central plants with new high-efficiency boilers, chillers, and variable-frequency drive motors. Other projects converted inefficient space heating systems to new radiant heating, thereby saving energy and improving working conditions. The ESPC team also tackled costs on the energy supply side. Honeywell assisted Fort Bragg in obtaining new rate structures with local gas and electric utilities and in making bulk purchases of natural gas, earning substantial savings for the installation. Fort Bragg continues to reinvest these savings into its infrastructure and improve the quality of life for soldiers on the installation. The Fort Bragg-Honeywell ESPC is part of Fort Bragg's Energy Management Modernization Program led by the Fort Bragg Directorate of Public Works (Honeywell 2005; USDOE 2002).

In addition, Fort Bragg has begun several demonstration projects for energy conservation. In partnership with the Corps of Engineers Construction Engineering Research Laboratory (CERL), the Public Works Business Center is currently using a 5-kilowatt (kW) natural gas fired fuel cell on one of its facilities. Installation engineers have begun using solar and wind-powered exterior lighting in lieu of the traditional electric lights. Currently these lights are at a remote access control point. If successful, off-grid lighting will be used in all force protection projects, saving money and providing exterior lighting even when grid power is unavailable. An additional photovoltaic power system is currently providing 200-kW for special operations (Sustainable Sandhills 2005; IMA 2004).

According to their 2030 Long-Range sustainability goals, Fort Bragg aims to reduce energy use in accordance with EO13123 as well as increase the use of renewable energy (Sustainable Sandhills, 2005). Fort Bragg also has to comply with the Army's Energy Campaign Plan and meet the requirements of EPAct 2005. Table I-1 provides energy use by source at Fort Bragg for 1984 to 2004. There are some data irregularities in the table and the resulting energy consumption data for 1998, 2001, and 2002 are not accurate.

The City of Fayetteville has furnished electricity to its citizens since 1900 through its Public Works Commission (PWC). The PWC's electric system involves the transmission and distribution of electric energy generated at their privately owned Butler-Warner Generation plant as well as that purchased from CP&L. The Butler-Warner Generation Plant is designed to provide power during peak consumption hours, when purchasing electricity is more expensive. PWC's strategic goals focus on being the most financially sound utility with the lowest responsible prices; maintaining,

strengthening, and expanding their core business; and providing quality, reliable utility services (PWC 2005).

As a result, PWC has continuously expanded its facilities to keep pace with the growth of its service area, which includes Fayetteville and a sizable area of Cumberland County. Expansion of the electrical system has been significant—from a 20,000 kW system (two substations) in 1960, to a 410,000 kW system (27 substations) in 1995, and over a 446,500 kW load today. PWC has three points of delivery of bulk electric power from CP&L—integrated into operation in 1969, 1973, and 1994 respectively. Power is received from CP&L at 230 kV and transformed to 66 kV. Transmission of electric power to substations is accomplished by more than 112 circuit miles of 66 kV lines, and serves a total of more than 71,150 electric customers, including 27 industrial customers (PWC 2005).

Between 1976 and 1980, PWC installed eight peak-shaving gas turbine generators capable of producing 192 megawatts (mW) of electricity. In 1988, six of these units were converted to a combined-cycle steam mode that increased generating capacity by approximately 68 mW, for a total of 260 mW of generating capacity. In 1993, a thermal energy storage (ice storage) system was added to the plant to reduce the cost of chiller operations during the summer peak season. Here, energy is stored as ice using low cost electricity at night to freeze Cryogel Ice Balls. The cool energy is then released the next day to keep peak energy use costs low. This brought the summer rating of the plant to 298 mW. This is the largest thermal energy storage plant in the world with 4.6 million gal of ice storage capacity (PWC 2005).

To further promote energy conservation, Fayetteville PWC participates in the NC GreenPower program. NC GreenPower is a statewide program designed to improve the quality of the environment by encouraging the development of renewable energy resources through consumers' voluntary funding of green power purchases by electric utilities in North Carolina. The program revenues will help provide financial incentives for generators of electricity from renewable sources such as the sun, wind and organic matter. Adding more renewable energy in North Carolina means cleaner air and a more stable energy supply for the future. A typical contribution of $4 per month adds one block of 100 kWh of green energy to North Carolina's power supply. Large-volume users—usually from the corporate sector – may contribute towards 100 or more blocks at a rate of $2.50 per block with a different energy mix (NC GreenPower 2005).

Table I1. Fort Bragg energy usage, 1984-2004.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
ELC	199,634	745,217	1,003,906	1,106,020	1,129,609	1,175,545	1,170,986	1,130,031	1,260,943	1,301,340	1,297,599
FOR	4,535	28,460	5,900	39,440	16,300	41,540	23,490	23,965	37,740	17,350	25,655
FSD	214,850	735,454	908,776	696,712	624,436	587,684	460,803	451,560	518,593	520,626	396,224
FSR	90,595	252,938	73,067	89,495	208,559	133,120	90,129	109,362	110,890	63,543	128,022
FSX											
NAG	348,637	1,193,449	978,929	1,150,747	1,063,063	1,126,186	1,004,649	1,010,400	1,058,623	1,026,934	1,038,217
PPG	13,739	45,062	51,560	44,271	63,115	52,073	50,754	50,357	57,839	54,190	39,312
TOTAL Million BTU	**871,990**	**3,000,580**	**3,022,138**	**3,126,685**	**3,105,082**	**3,116,148**	**2,800,811**	**2,775,675**	**3,044,628**	**2,983,983**	**2,925,029**

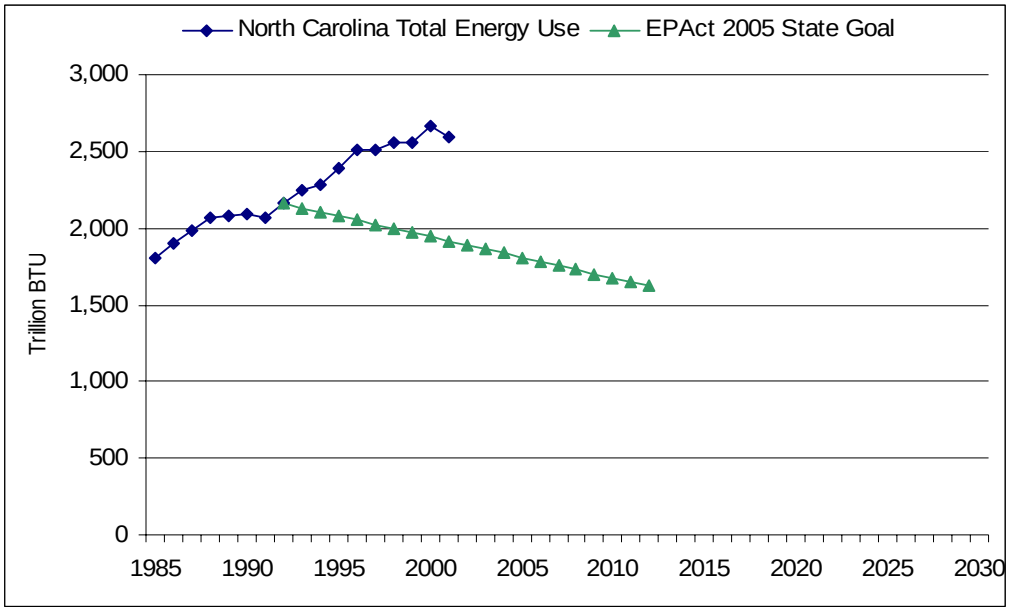
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
ELC	1,303,298	1,343,234	1,305,669	797,248	1,699,442	1,877,789	1,626,283	23,379	1,545,834	1,317,894	
FOR	30,245	18,815	48,580	640							
FSD	363,303	396,602	336,487	311,451	271,586	205,676		125,046	442,909	346,955	
FSR	172,459	222,993	52,628								
FSX					25,100					129,260	
NAG	1,062,644	973,090	907,081	723,607	1,270,707	1,476,974	1,071,714	1,058,799	968,760	1,095,442	
PPG	19,475	20,287	21,413	11,821	18,612	18,162	18,656	16,466	14,107	13,295	
TOTAL Million BTU	**2,951,424**	**2,975,021**	**2,671,858**	**1,844,767**	**3,285,447**	**3,578,601**	**2,716,653**	**1,223,690**	**2,971,610**	**2,902,846**	

Source: Headquarters Army DUERS Data System (HQRADDS), 2005

Measuring the Gap around Fort Bragg

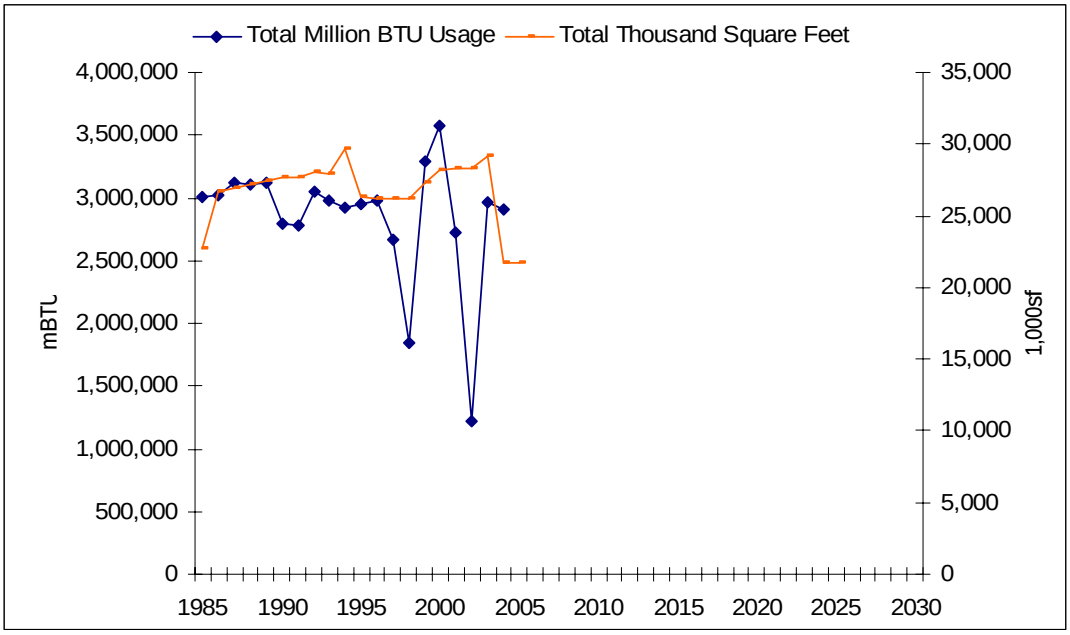
Today, Fort Bragg is seeing significant reductions in energy costs (25 percent). However, overall energy consumption is not being reduced at Fort Bragg, within the City of Fayetteville, the surrounding region, or the state of North Carolina. Figure I1 illustrates total energy use (trillion Btu) within North Carolina from 1985 to 2001 (EIA, 2005) in contrast with EPAct 2005 state goals. North Carolina is not on track for EPAct 2005 compliance. In 2000, the state was 725 trillion Btu behind the glide path and the deficit was growing at an average annual rate of 9 percent.

From Figure I2, Fort Bragg shows erratic energy usage, which is most likely due to reporting deficiencies—particularly in 1998, 2001, and 2002. In recent years, Fort Bragg has managed significant energy reductions in the face of increasing building space. Federal officials have described the Honeywell-Fort Bragg partnership as a pacesetter in the ESPC approach to help achieve the Army's long-range goal—EPAct 2005. More energy-savings contract work has been done at Fort Bragg than at any other facility. As a result, Fort Bragg has turned around its energy consumption trend and shown drops in energy consumption. Yet, the question remains whether or not Fort Bragg can maintain energy conservation over the long run and in the face of changing missions and a growing regional population.



Source: U.S. Department of Energy. Energy Information Administration, 2005; EPAct (Public Law 109-58), 2005

Figure I1. North Carolina State Energy Usage

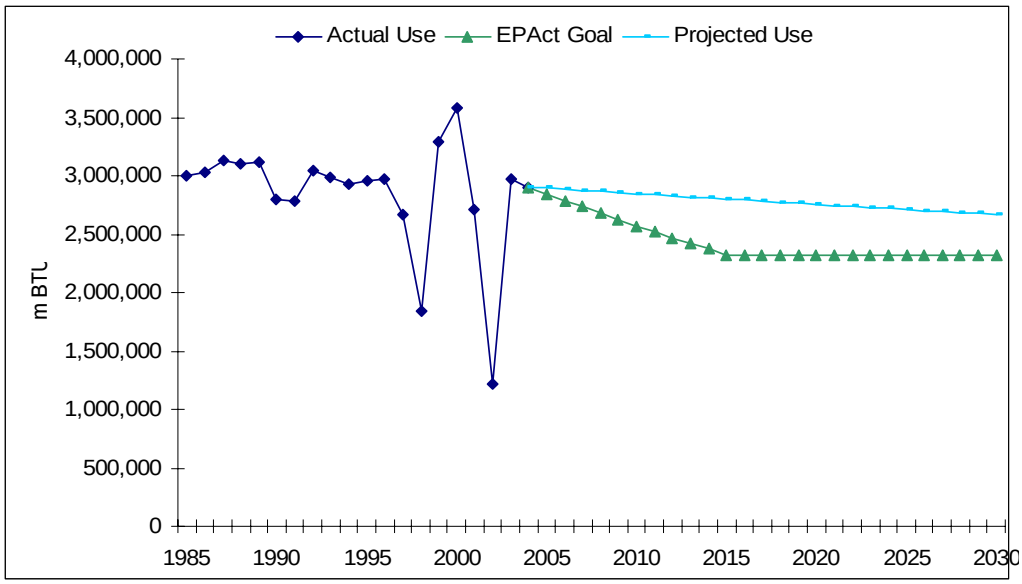


Source: Headquarters Army DUERS Data System (HQRADDS), 2005

Figure I2. Historic Fort Bragg Energy Usage (ELC, FOR, FSD, FSR, FSX, NAG, and PPG consumption).

Fort Bragg facility energy consumption was extrapolated to 2030 from the Headquarters Army DUERS Data System (HQRADDS). Since 1985, Fort Bragg has reduced overall energy consumption by an annual average of only 0.33 percent. Given that Fort Bragg is not scheduled to alter its military population or current missions, it may be assumed that this slow rate of reduction will continue. Continuing at this rate of reduction will not allow Fort Bragg to meet it goal of fulfilling EPAct 2005 installation goals. By 2030, Fort Bragg will remain over 344,290 MBtu above EPAct 2005 goals. To meet EPAct 2005 goals, Fort Bragg must reduce energy consumption by at least 2 percent annually. Refer to Figure I3 for a visualization of these numbers.

Although Fort Bragg is not scheduled to alter its military population, the Fayetteville region's population is growing and is predicted to increase 25.6 percent by 2030 (LEAM™ 2005). As the population grows, energy demand inevitably increases. To model energy projections for Fayetteville, building energy use data was obtained from the U.S. Department of Energy. Residential energy use data was obtained from the Energy Information Administration of the USDOE. The data is organized in several different categories and degrees of specificity. The data used in the model was related to census region. North Carolina falls into the Southeast Census Region. Data for this region was normalized by housing type and age and was further broken down by fuel type. Tables I2 and I3 list energy factors.



Source: Headquarters Army DUERS Data System (HQRADDS), 2005; EPAct (Public Law 109-58), 2005; LEAM™, 2005

Figure I3. Fort Bragg energy gap (ELC, FOR, FSD, FSR, FSX, NAG, and PPG consumption).

Table I2. Existing stock residential energy use/household/year.

Existing Stock Annual Energy Use Per Household		
Energy Source	Low Density	High Density
Electricity	52.9 MBtu/yr	28.9 MBtu/yr
Natural Gas	27.2 MBtu/yr	14.6 MBtu/yr
Fuel Oil	3.2 MBtu/yr	1.8 MBtu/yr
Kerosene	0.8 MBtu/yr	NA
Liquefied Propane Gas	3.96 MBtu/yr	NA
Wood	2.97 MBtu/yr	NA

Table 3. New buildings residential energy use/household/year (EIA 2001).

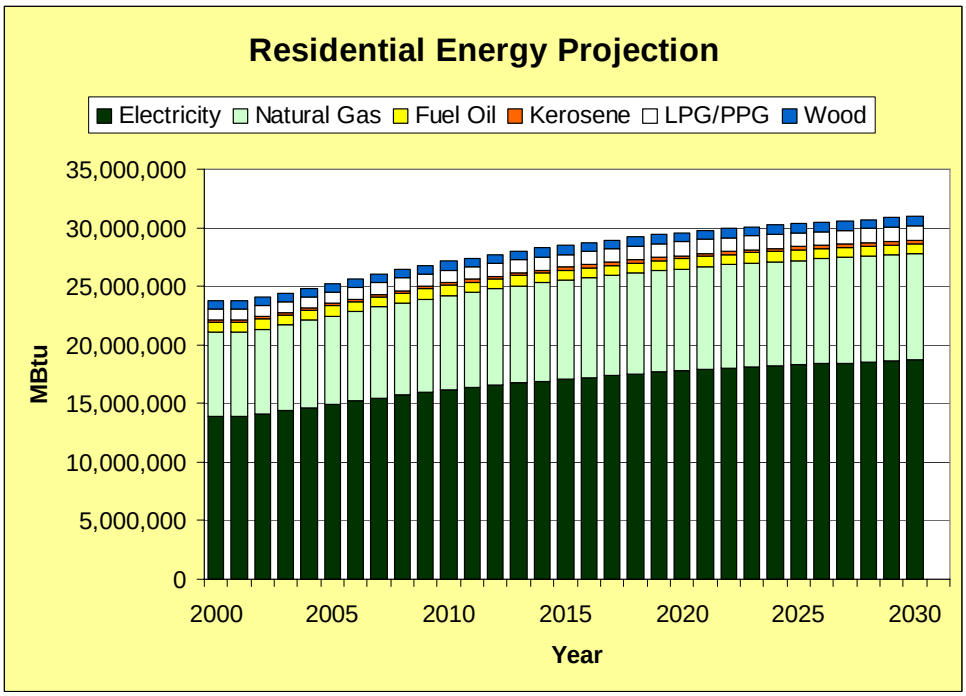
New Buildings Annual Energy Use Per Household		
Energy Source	Low Density	High Density
Electricity	63.6 MBtu/yr	35.8 MBtu/yr
Natural Gas	25.9 MBtu/yr	13.9 MBtu/yr
Fuel Oil	.7 MBtu/yr	0.4 MBtu/yr
Kerosene	1.0 MBtu/yr	NA
Liquefied Propane Gas	4.16 MBtu/yr	NA
Wood	1.6 MBtu/yr	NA

Automotive energy use is based on U.S. average figures and census region figures as follows: average U.S. household gasoline consumption is 1,143 gallon per year. The South Atlantic Census Region consumption is 1,145 gal/household. This is based on 20.4 million households in the census region with vehicles. Assumptions for autos per household are from Residential Energy Consumption Survey (RECS) and are as follows: 30.5 percent have one car, 42.4 percent have two cars, 13.8 percent have three cars, 4.4 percent have three or more cars, and 8.9 percent have no cars. The U.S. average is 1.9 vehicles per household having vehicles. The South Atlantic number is also 1.9. The model assumes that 8.9 percent of the new households will not have cars. The rest will consume gasoline at the regional average rates (DOE 2001).

The 7-county region surrounding Fort Bragg is projected to acquire an additional 80,637 households by 2030 (LEAM™ 2005). Fayetteville, itself, is projected to acquire an additional 36,452 households by 2030 (LEAM™ 2005). Figure I4 illustrates projected household energy usages for the Fayetteville region. In total, electricity consumption is expected to increase by over 4,700,000 MBtu, natural gas by over 1,900,000 MBtu, and fuel oil by over 52,000 MBtu. This represents an overall 29 percent increase in energy consumption to this sector. Gasoline consumption by automobiles is expected to increase by 10.5 million MBtu (over 84,000,000 gal) per year by 2030.

A disadvantage of using data this way is that geographically diverse regions may be in the same census region while using a different mix of fuels for heating and generating electricity. This can give inaccuracies when calculating air pollution and, hence, societal costs. Household energy use varies depending on the density of housing. Low density residential units use about twice as much energy per unit as high density residential units. This is due in part to significantly smaller housing size. It is also due to the efficiencies of sharing walls, in multi-family housing (Center of Excellence for Sustainable Development, 1997).

Energy consumption in commercial/industrial buildings was calculated by using planning rules of thumb regarding building footprint to total land area ratios. Each hectare (107,637 square feet) of land designated with a commercial/industrial land use contains 32,291 square feet of building foot print. Energy use values were taken from the EIA Commercial Buildings Energy Consumption Surveys of 2004 for the South Atlantic Census Region. Table I4 shows the energy use of commercial/industrial buildings by fuel type.



Source: U.S. Department of Energy. Energy Information Administration, 2000-2003; LEAM™, 2005

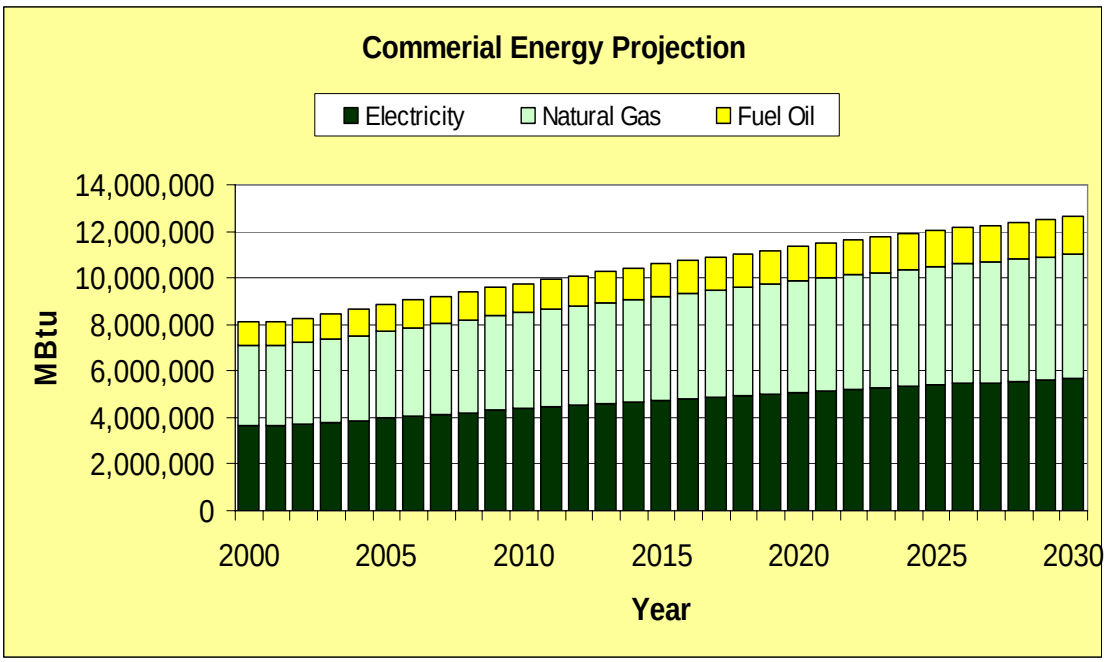
Figure I4. Fayetteville region residential energy use projections.

Table I4. Commercial/industrial energy use/building/year.

Energy Source	Consumption
Electricity	47.1 kBTU/sf/yr
Natural Gas	44.1 kBTU/sf/yr
Fuel Oil	13.5 kBTU/sf/yr
Source: Source: U.S. Department of Energy. Energy Information Administration, 2004	

The Fayetteville 7-county region is projected to gain over 43 million commercial/industrial building square feet by 2030 (LEAM™ 2005). Figure I5 shows projected commercial/industrial energy usages. In total, electricity consumption is expected to increase by over 2,000,000 MBtu, natural gas by over 1,900,000 MBtu, and fuel oil by about 600,000 MBtu. This represents a 55% increase in energy consumption to this sector.

Regional growth rates explain significantly increasing energy consumption rates within North Carolina and the Fort Bragg region as well as the predicted failure of each to meet EPAct 2005 goals. Overall, Fort Bragg accounts for about 10 percent of the total energy consumption within the 7-county region and about 20 percent of Fayetteville's total energy consumption.



Source: U.S. Department of Energy. Energy Information Administration, 2004; LEAM™, 2005

Figure I5. Fayetteville total commercial/industrial energy use projections.

Even if Fort Bragg got on track with the 2 percent average annual decrease in energy consumption, regional consumption would still go up significantly from desired EPAct 2005 state goals. For this region to sustain energy availability, all individual service providers must strive to reduce per capita electricity and fossil fuel use. Energy sustainability requires that decision makers, planners, developers, special interests, and politicians perceive of their communities as part of a larger system, with the success of any single component dependent upon the success of the system.

CP&L's and NCNG's capability to meet increasing regional demands will impact energy rates. Currently, Fort Bragg and Fayetteville experience average energy rates that are below national averages. Using electric residential rates as an example, Fort Bragg's and Fayetteville's average rates are $0.0705 and $0.069 per kWh respectively (PWC 2005). The national average is $0.0897 per kWh.

Since most homes in the region are all electric, electrical demand from the residential growth alone is expected to increase 28 percent or about 800 MW, requiring a new large power plant to service the area. The NERC regional assessment of Southeastern Reliability Council (SERC) forecasts capacity margins declining in the later years of the planning horizon. Specifically for the SERC subregion VACAR, capacity margins are expected to decline from 16.7 percent in the summer of 2005, declining to 15.5 percent

to 11.7 percent in 2013. Capacity in addition to the currently planned will be needed to maintain reliability. Large amounts of merchant generation in the subregion could provide the needed capacity and adequate time remains to build new capacity if necessary, so the low capacity margins in the later years are not a reliability concern at this time (NERC 2004).

PWC's Butler-Warner Generation Plant maintains a capacity of 285 megawatts, while the entire system's peak demand reaches as high as 446.5 megawatts. PWC has the capability of supplementing a majority of the peak demand, as CP&L and NCNG are both certain to continue to grow with their markets to sell and distribute energy. Thus, to preserve energy availability at affordable costs, Fort Bragg's agreements with the energy supplier will be critical. Another factor is that deregulation within the energy industry may take place in North Carolina, which could result in service variance and higher costs.

Fort Bragg is continuing to undertake programs to help reduce reliance on fossil fuel and increase cost-effective energy supplies from renewable sources. For example, Fort Bragg hopes to integrate the use of compressed natural gas vehicles and fueling stations on-base. For Fort Bragg to reach its energy long-term sustainability goals, it must continue to work with its private partners to manage the efficiency of on-base distribution systems, ensure affordable costs, and promote cleaner sources of energy.

Fort Benning/Columbus, GA

Electrical power in the Columbus region is provided by several major companies: Georgia Power, Troup Electric Membership Corporation, Oglethorpe Power Corporation, Flint Energies, and Sumter Electric Membership Corporation. Georgia Power is the main provider for the City of Columbus, while Flint Energies is the provider for Fort Benning. Flint Energies was successful in its 1996 proposal to acquire the ownership and operational responsibilities of Fort Benning's electrical energy system. The utility privatization of Fort Benning was one of the first DoD installations to be outsourced. Shortly thereafter, Fort Benning privatized its natural gas system to United Cities Gas Company of Columbus. The city of Columbus is serviced by numerous natural gas companies including Georgia Natural Gas and ATMOS Energy.

Fort Benning, in partnership with Flint Energies, has made significant progress in reducing energy use intensity primarily through their aggressive program to decentralize their building heating system. Fort Benning

has replaced three large central energy plants in favor of smaller, more efficient building-level boilers. To further enhance energy efficiency, Fort Benning has completed two ESPC projects with Ameresco. The first project costing $500,000 covered the "starship" battalion barracks while the second project, completed in 1999 and totaling $7 million, covered 139 buildings. Both projects included lighting and other miscellaneous measures. Fort Benning has also installed light emitting diode (LED) traffic lights throughout the installation (IMA 2004).

Fort Benning is substantially ahead of the glide path for compliance with EO13123 and EPAct 2005, and was awarded the Secretary of the Army Energy and Water Management Award for 2004 for Energy Efficiency/Energy Management at the installation level. Table I5 provides energy use by source at Fort Benning for 1984 to 2004. Moreover, Fort Benning has been active in the search for cost-effective energy alternatives. In 1984, Fort Benning was home to the world's largest solar pond—a system involving eighty 200 foot-long water-filled black plastic modules and 3.6 miles of pipe supplying 6,500 troops with 500,000 gal of hot water daily. Unfortunately, the system broke-down in the mid 90s and was deemed un-repairable. Today, Flint Energies has installed the first fuel cell at a recreation center on-base. The fuel cell produces 5 kW and weighs a ton. It has the capability of providing power for a single-family detached home. Flint was awarded a grant in March 2004 by the DoD to install the fuel cell system. Additionally, Fort Benning recently opened the first E-85 ethanol fuel station at an Army post exchange.

Like Fayetteville's PWC, Georgia Power is a business striving to expand its customer base by providing quality, cost competitive, and reliable utility services. Georgia Power, a unit of Southern Company, also supports environmental stewardship through its Green Energy Program. Similar to the North Carolina GreenPower Program, the Green Energy Program is available to all customers in 100-kW-hr blocks for a 12-month period (about 10 percent of an average monthly residential electricity bill). Each block adds $5.50 (+tax) to the monthly electricity bill (Georgia Power 2005).

Fort Benning is in the process of finalizing its long-term energy goals. In their draft plan, Fort Benning's goals include a "no net increase" in fossil fuel energy usage regardless of any population/building square foot increase on-base. Fort Benning would also like to see increases in the use of renewable energy—specifically in government tactical and non-tactical vehicles and material handling equipment fuel.

Table I5. Fort Benning energy usage, 1984-2004.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
ELC	172,766	860,532	908,348	916,656	955,781	993,612	1,049,610	1,049,617	986,136	976,014	940,823
FOR	2,740	6,635	7,465	5,075	13,635	10,230	7,195	16,445	14,700	24,595	18,305
FSD	59,643	228,632	182,417	226,436	209,454	142,532	31,396	31,187	40,665	76,088	51,190
FSR	817	39,457	38,131	19,502	59,531	956	49,227				
FSX	43	177	167	142	137	120	108	90	78	60	66
NAG	481,784	1,881,444	1,934,392	2,069,185	1,921,883	2,002,106	1,931,206	1,891,165	1,918,119	1,890,377	1,683,951
PPG	26,543	99,624	94,701	96,260	83,398	59,689	47,076	49,531	51,995	43,022	46,800
TOTAL Million BTU	744,336	3,116,501	3,165,621	3,333,256	3,243,819	3,209,245	3,115,818	3,038,035	3,011,693	3,010,156	2,741,135

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
ELC	957,728	1,004,846	1,030,692	751,212	999,167	1,084,463	1,062,724	1,108,904	1,047,334	1,067,197	
FOR	18,140	7,190	14,930	13,710	7,445						
FSD	51,231	87,779	63,557	9,397	4,935	2,226	20,481		3,466		
FSR											
FSX	262	66	56	4,279	6,513	3,520	4,584	3,720			
NAG	1,723,768	1,790,471	1,652,294	1,445,434	1,256,522	1,140,765	1,039,226	1,003,442	874,694	1,043,909	
PPG	54,718	84,871	48,246	37,259	64,960	45,487	43,794	40,093	47,448	41,754	
TOTAL Million BTU	2,805,847	2,975,223	2,809,775	2,261,291	2,339,542	2,276,461	2,170,809	2,156,159	1,972,942	2,152,860	

Source: Headquarters Army DUERS Data System (HQRADDS), 2005.

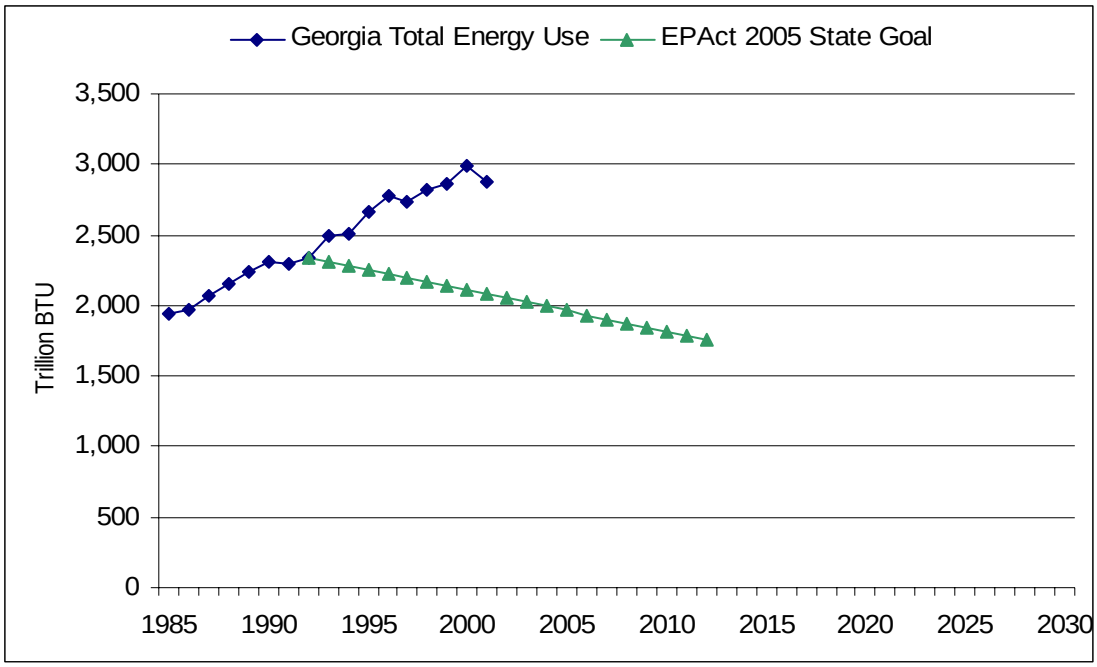
Measuring the Gap around Fort Benning

Like North Carolina, the state of Georgia is not on a path to meet EPAct 2005 state guideline (as shown in Figure I6). Consumption rates for the state have already grown by 23 percent from 1992 to 2001 while guidelines aim for a 25 percent reduction from 1992 to 2012.

Fort Benning, on the other hand, is experiencing decreasing consumption rates. Figure I7 shows a 31 percent decrease in total energy consumption from 1984 to 2004. As mentioned previously, Fort Benning has already met compliance standards for EO13123, and is well on its way to meet EPAct 2005 installation goals. However, Fort Benning is also on the brink of a major period of growth, change, and transformation.

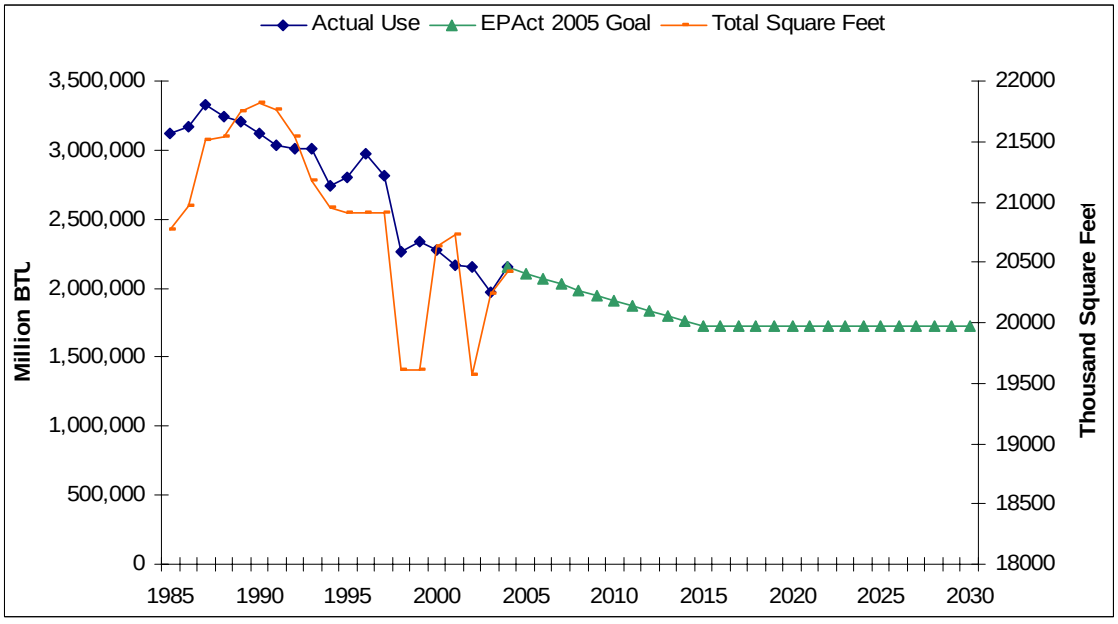
The combination of Army transformation, Integrated Global Presence and Basing Strategy (IGPBS), and BRAC has mandated an additional 3,662 military personnel and 2,000 civilians/contractors plus family members to Fort Benning over the period of 2005 to 2011. This not only means increasing on-base population and building square footage, but also an immediate increase in regional population providing support services to the military.

Maintaining current consumption rates with an increased population, Fort Benning will most likely require and additional 206,305 MBtu of energy under Army transformation. This does not meet Fort Benning's drafted long-term sustainability goals. In fact, it is predicted to lead Fort Benning to 490,212 MBtu over EPAct 2005 goals by 2011. For Fort Benning to maintain current energy consumption rates regardless of increasing population and building square footage, they must find a way to provide energy for an additional 5,662 personnel without increasing consumption. Figure I8 shows projected consumption versus the EPAct 2005 goal. Historically, total energy consumption on Fort Benning has generally followed available building square footages. Hence, as total building square footages rise in the forthcoming years (2009 to 2011), increases in total consumption seem inevitable unless extraordinary measures are taken. It is imperative that all new construction meet EPAct requirements and consume 30 percent less than the current energy design standards. Renewable energy alternatives must also be aggressively pursued.



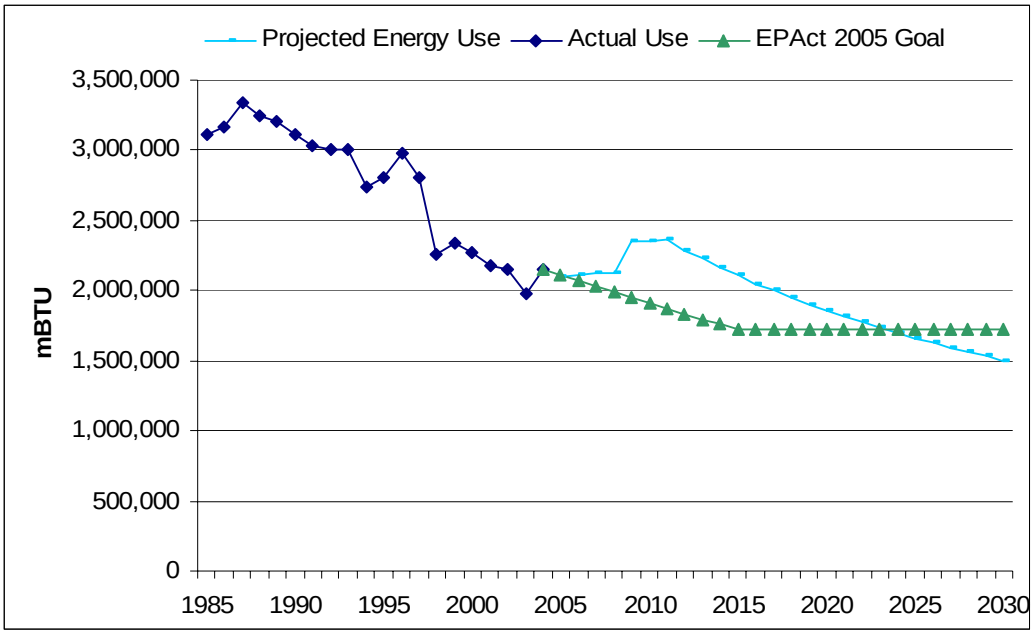
Source: U.S. Department of Energy. Energy Information Administration, 2005; EPAct (Public Law 109-58), 2005

Figure I6. Georgia State energy usage.



Source: Headquarters Army DUERS Data System (HQRADDS), 2005; EPAct (Public Law 109-58), 2005; LEAM™, 2005

Figure I7. Fort Benning energy usage.



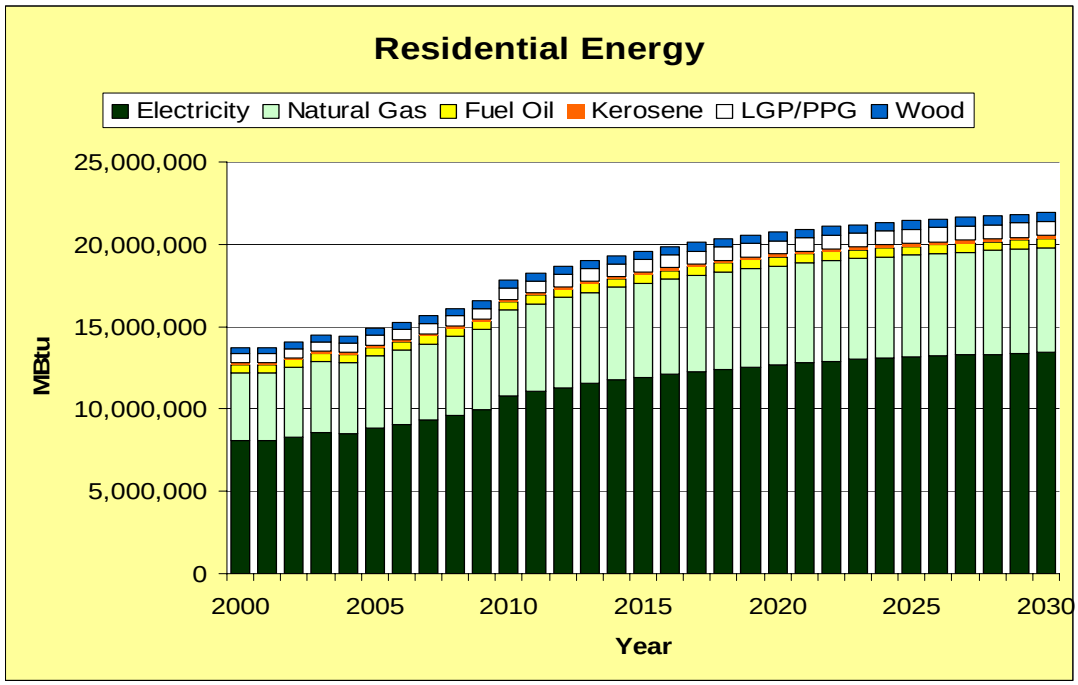
Source: Headquarters Army DUERS Data System (HQRADDS), 2005; EPAct (Public Law 109-58), 2005; LEAM™, 2005; BRAC, 2005

Figure I8. Fort Benning glidepath with 2005 BRAC plus-up.

The 8-county region around Fort Benning and Columbus, Georgia, will likely experience an additional 76,071 households and 88 million commercial/industrial sq ft by 2030 without counting a BRAC plus-up of troops (LEAM™ 2005). However, taking into account BRAC transformation (plus-up of troops and their families) the Columbus region is projected to experience an increase of 91,747 households and 107 million commercial/industrial sq ft. Using the same energy models (Tables I-2, I-3, and I-4), Figure I9 illustrates the increases in residential energy consumption given the impact of BRAC transformations.

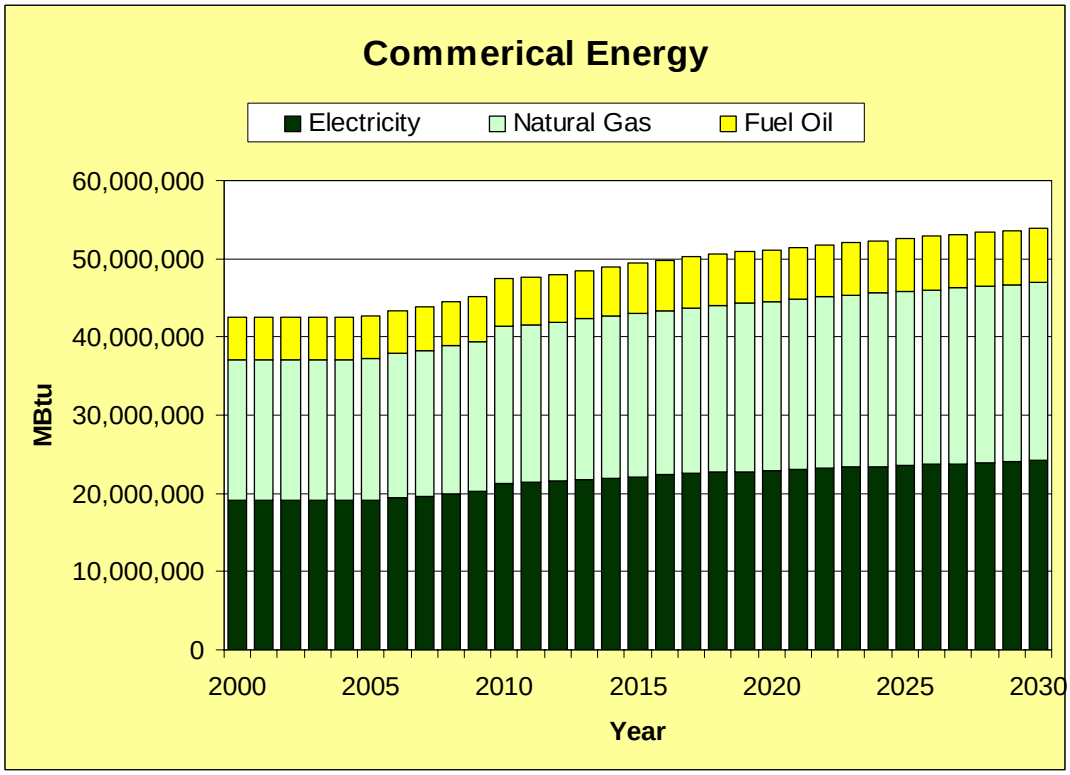
Figure I10 illustrates projected increases in commercial/industrial energy consumption given the impact of BRAC transformations. The eight-county region surrounding Fort Benning is predicted to acquire 87,331,669 commercial/industrial sq ft by 2030 without accounting for BRAC transformations and 106,649,267 commercial/industrial sq ft with accounting for BRAC transformations (LEAM™ 2005).

Local energy providers have and will continue to strive to meet increasing local demands. Regional energy growth and consumption on this order is not sustainable for the long-term. EPAct 2005 requires a consumption reduction for energy efficiency. Without regional cooperation; these goals will not be met. Like Fort Bragg, Fort Benning is only one component of the region—consuming only about 3.5 percent of the total energy.



Source: U.S. Department of Energy. Energy Information Administration, 2000-2004; LEAM™, 2005

Figure I9. Columbus region total plus-up residential energy use.



Source: U.S. Department of Energy. Energy Information Administration, 2000-2004; LEAM™ 2005

Figure I10. Columbus area commercial/industrial energy use.

The 30-year growth projection will add an additional 48 percent in energy consumption if present consumption patterns prevail. Despite Fort Benning's successes, if the region does not seriously consider ways to reduce its energy consumption, both Fort Benning and its region will be in jeopardy.

Fort Bragg and Fort Benning share the same NERC region—SERC whose future reliability is not of major concern. Specifically for the SERC subregion Entergy, capacity margins are expected to decline from 9.9 percent in the summer of 2005 to 0.5 percent in 2013. Again, large amounts of merchant generation in the subregion could provide the needed capacity and adequate time remains to build new capacity if necessary. The low capacity margins in the later years are not a reliability concern at this time (NERC 2004 Long-Term Reliability Assessment). Additionally, current energy rates are well below national averages. Using residential electric rates again as an example, Fort Benning's average rate is $0.0468 per kWh; Georgia Power customers pay an average rate of $0.0404 per kWh (national average is $0.0897 per kWh).

In preparation for Army transformation, Pacific Northwest National Laboratory (PNNL) undertook a site-wide energy assessment at Fort Benning in January 2003 and delivered a report on this assessment in June 2004. This assessment identified cost-effective projects saving over 250 MBtu/yr (16 percent) and $2.1 million/year. A follow-on energy planning workshop was held at Fort Benning 28-29 July 2004. The purpose of the workshop was to establish a plan for project identification and implementation through the Fort Benning Long-Range Energy Management Plan.

Fort Benning may appear well on its way to meeting EO13123 and EPAct 2005 with its long-terms goals. They still must maintain an aggressive energy efficiency program and consider more possibilities for alternative energy sources. Fort Benning has a focused effort toward aggressive energy conservation practices. While on the surface it has experimented with alternative energy sources (the solar pond and fuel cell programs previously mentioned are examples), Fort Benning has yet to capitalize on these ventures. In fact today, Fort Benning uses no solar or biomass energy despite favorable regional conditions for their use. Obviously, the trick is making renewable energy ventures cost-effective, and for Fort Benning, no experiments have proven to be so.

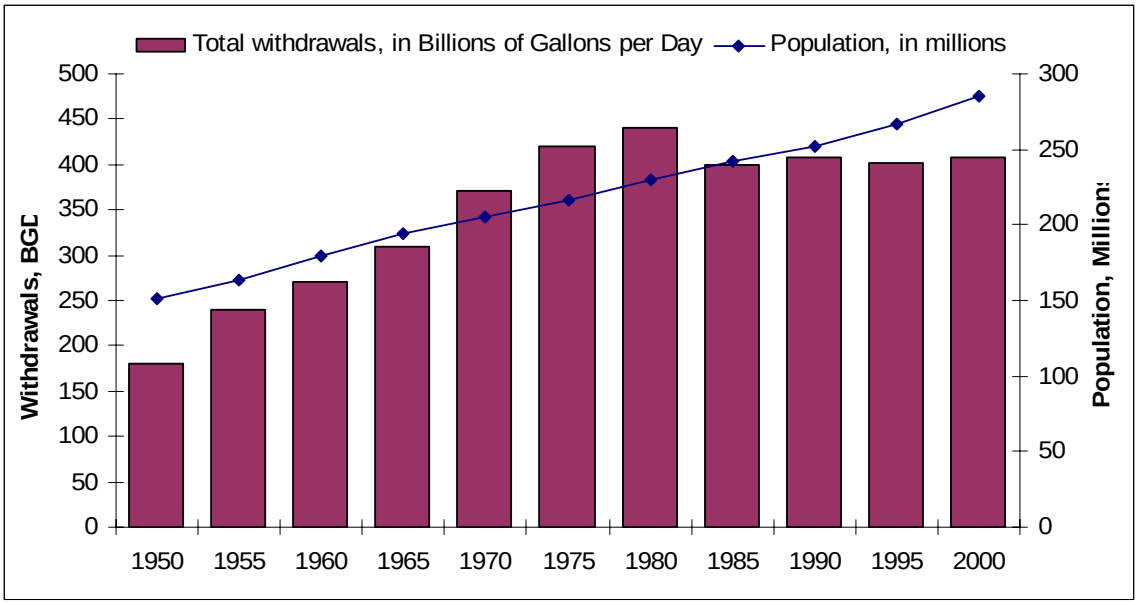
Appendix J: Water Gap Analyses

Water Usage and Trends

The demand for water in the United States necessitates a multitude of resource utilization techniques. These include stream and river impoundments, the drilling of more and deeper wells, and water withdrawals from most natural water bodies across the country. The high demand for and overuse of water can contribute markedly to nonpoint source pollution in various forms, including: altered instream flows due to surface withdrawals; saltwater intrusion due to excessive withdrawals; and polluted runoff resulting from the excess of water applied for irrigation and landscape maintenance that carries with it sediments, nutrients, salts, and other pollutants. Other adverse effects result from the damming of rivers to create large reservoirs. In addition to impacts on natural habitats, dams create several forms of nonpoint source pollution from their effects on physical and chemical water quality degradation both up- and downstream.

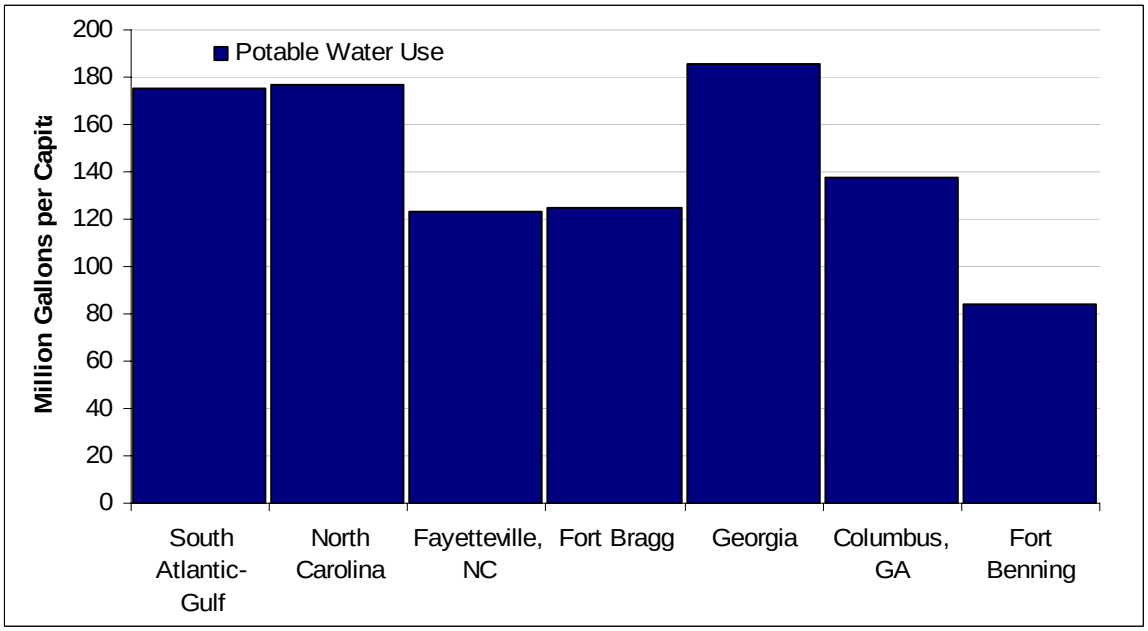
There are several different ways to categorize water use. This report focuses on per capita use of public water supplies for industrial, commercial, and residential uses. The average per capita use can vary greatly between communities for any number of reasons. These can include climate differences; the mix of domestic, commercial, and industrial uses; household size and income brackets; public uses; and age, complexity, and condition of distribution system. For instance, per capita use of public water is about 50 percent higher in the West than the East. This is mostly due to the amount of landscape irrigation in the West. However, per capita use can also vary greatly within a single state. Therefore, it is critical to examine water consumption in the context of regional patterns in water use.

Figure J1 shows water withdrawals for public use in the United States from 1950 to 2000. Overall, the national per capita use is decreasing due to a combination of various factors, though conservation rates low in the priority order. Figure J2 shows current per capita water use for areas related to the in the Fall Line Region, including Forts Bragg and Benning, the local communities of Fayetteville, NC, and Columbus, GA, respectively, the states of North Carolina and Georgia, and the South Atlantic Gulf. Generally, Forts Bragg and Benning and their local communities use less water per capita than their regional consumption rates. The practices, goals, and projections for Forts Bragg and Benning follow.



Source: U.S. Environmental Protection Agency, 2003

Figure J1. U.S. trends in population and water withdrawals, 1950-2000.



Source: U.S. Environmental Protection Agency, Fayetteville Public Works Commission, Fort Bragg, Columbus Water Works, and Fort Benning, 2005

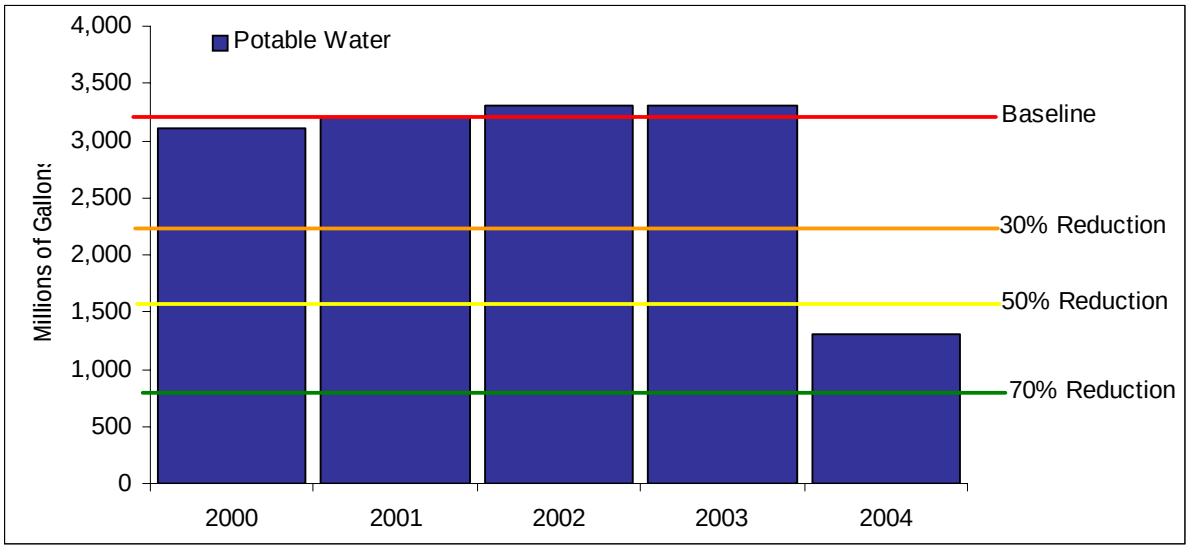
Figure J2. Average annual water use per capita, industrial, commercial, and residential water use, 2004.

Fort Bragg/Fayetteville Region

Fort Bragg is committed to sustainable practices as it relates to the use and discharge of water resources. Although Fort Bragg retains ownership of its water systems, it is seeking a contractor to assume management of the supply and waste water treatment systems. The system manager will also be expected to continually identify ways to reduce water consumption and the generation of waste water, while improving the quality of waste water discharges. In its long-term sustainability goals, Fort Bragg aims to reduce the amount of water taken from its water source, the Little River, by 70 percent and have all discharges meet or exceed North Carolina's high quality water standard.

In the past, Fort Bragg's wastewater treatment plant (WWTP) has been non-compliant with National Pollutant Discharge Elimination System (NPDES) permits issued by the USEPA (Sustainable Sandhills 2005). If the Little River falls under stricter requirements or national discharge limits are altered, the WWTP will need to be upgraded to meet the more stringent limits. In the recent past, the region around Fort Bragg has been experiencing an extreme regional drought, which has led to a significant decrease in the Little River water availability. As a result, Fort Bragg was forced to purchase water from the City of Fayetteville to meet mission and quality of life requirements. Moreover, Fort Bragg enacted mandatory water restrictions and adopted a new installation-wide permanent water conservation policy to help regulate the use of potable water throughout the year. Within 6 weeks, water usage had decreased by nearly 30 percent (Pfau 2004) and has remained at that level. This has taken the installation to nearly half of the 70 percent reduction as specified in its long-term goals (Figure J3).

Fort Bragg's water conservation policy applies to all users and customers of water treated by the Fort Bragg Water Treatment Plant. The policy lists "expectations to conserve water each and every day through conscientious practices." Examples of restrictions include a requirement that residents living in odd number houses can water their lawns on odd number days only and even number houses on even number days only. Watering is strictly limited to the hours of 7:00 to 10:00 a.m. and 7:00 to 9:00 p.m. to reduce evaporation and no more than 30 to 45 minutes of watering per location is permitted.



Source: Headquarters Army DUERS Data System (HQRADDS), 2005

Figure J3. Fort Bragg water consumption.

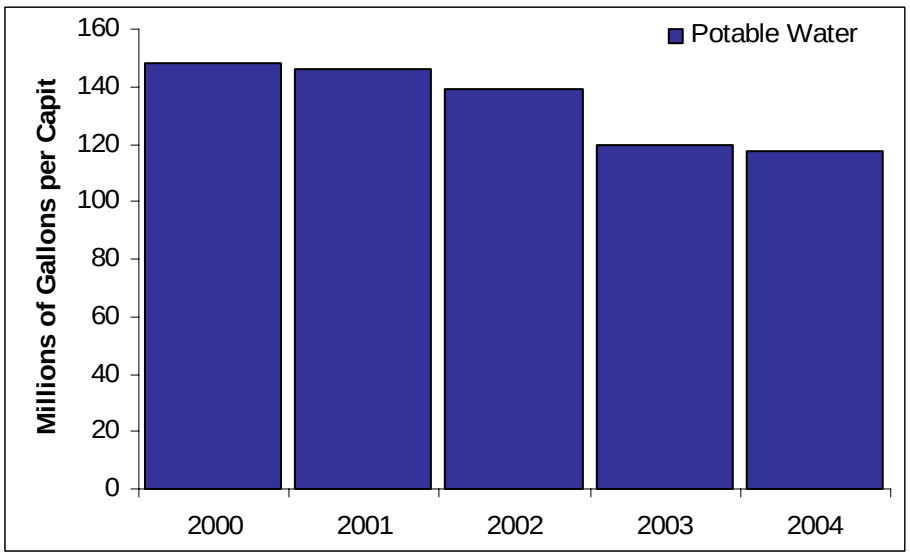
The Little River is part of the Cape Fear Basin and is the primary drinking water source for Fort Bragg. Contamination of regional water resources, particularly by sediments, is a critical consideration in North Carolina. This is due to the economic impacts associated with destruction of fish habitats, costs of water treatment, and the decrease of reservoir holding capacity. An adequate supply of clean water is an increasing concern in the State and has become a priority for the North Carolina Department of Environmental and Natural Resources (NCDENR). As a result, Fort Bragg will see increased regulatory and public scrutiny placed on their water protection program.

North Carolina has proposed a project for inter-basin transfer to divert water from Upper Cape Fear River Basin to Neuse River Basin in support of enormous urban growth. This loss of capacity from the Little River may necessitate development of groundwater sources for drinking water. However, due to overuse, potential groundwater sources for Fort Bragg consumption are steadily declining. The Fort Bragg area is underlain by three aquifers: the Saprolite-basement, the Cape Fear, and the Middendorf aquifers. The Upper Middendorf aquifer is considered to be polluted beyond drinking water limits (PWBC 2003). The sandy soils in the Sandhills hydrologic area are highly permeable and allow rapid infiltration of precipitation. This is the primary source of ground-water recharge for Fort Bragg. This also allows rapid infiltration of pollutants. In addition to the condition and quantity of groundwater availability, privatization of Fort Bragg

water systems may cause an increase in the price of water as rates are commercialized.

The Fayetteville Pubic Works Commission (PWC) provides water to local residents from the Cape Fear River and Glenville Lake. The Fayetteville PWC currently maintains two water treatment facilities—Glenville Lake and P.O. Hoffer. Figure J4 shows the average daily demand per capita these two treatment facilities supply. The Glenville Lake Water Treatment Facility has an operating capacity of 18 MGD and a current average daily consumption of 8.33 MGD. The P.O. Hoffer Water Treatment Facility has a 32 MGD capacity and 15.45 MGD use. Glenville Lake was last updated in 1994 and has no expansion plans. P.O. Hoffer was last updated in 1988 and currently has plans to increase treatment capacity to 40 MGD. Both plants are aware that additional treatment units may be needed to meet Safe Drinking Water Act requirements (PWC 2005).

In terms of wastewater treatment, the Fayetteville PWC operates Cross Creek and Rockfish water reclamation facilities. The current treatment capacities are 25 MGD and 16 MGD, respectively. Each facility experiences a maximum monthly flow of approximately 15.5 MGD. Rockfish Water Reclamation Facility is currently in phase 2 of a 3 phase expansion to bring capacity to 24 MGD (PWC 2005).



Source: Fayetteville PWC, 2005

Figure J4. Fayetteville average daily demand per capita.

Fayetteville PWC endeavors to maintain efficient water and wastewater treatment facilities operating well under capacities. The Fayetteville PWC

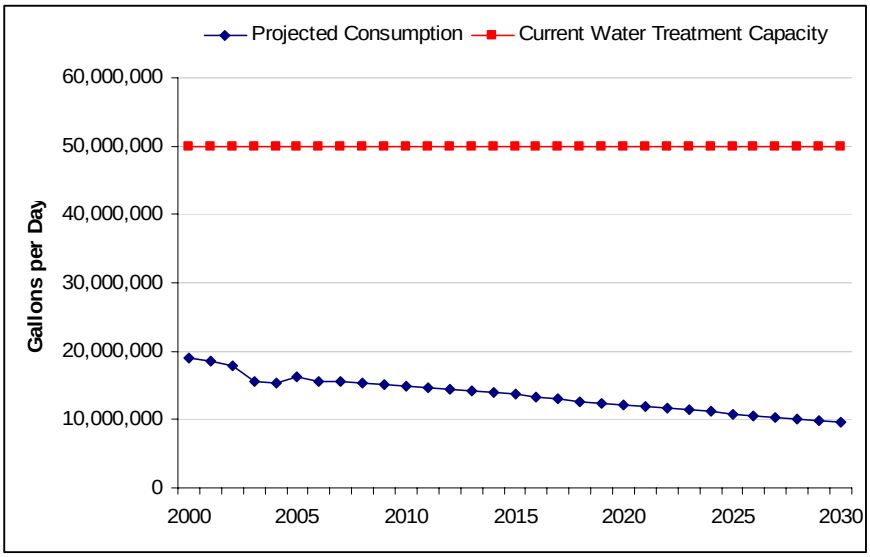
will continue to meet the needs of its community, but like Fort Bragg, it will have to cope with increasing scrutiny and regulations from NCDENR. Depending on the requirements, the treatment facilities, both water and wastewater, owned by PWC and Fort Bragg will have to adjust their operations in the future.

Measuring the Water Gap around Fort Bragg

Fort Bragg's 70 percent reduction goal translates into use of 902 million gal annually. Currently, Fort Bragg consumes 1,300 million gal annually. To reach their goal, Fort Bragg needs to reduce annual consumption by nearly 400 million gal (Figure J3). Given no predicted changes in population or mission, a 400 million gal decrease in consumption appears possible. However, the installation has also gone to great lengths to reach the level of consumption they have and reduced nearly 2,000 million gal off their annual consumption. Thus, dropping an additional 400 million gal of consumption will be challenging.

In Fayetteville, average daily per capita demand is decreasing by an average of 2.07 percent per year (Figure J4). Assuming this trend to continue and given the projected population growth, Fayetteville is predicted to consume 9,683,463 gal/day—73 gal/day/capita—by 2030 (LEAM™ 2005) (Figure J5). This is well below current water treatment capacities of 50 MGD. Despite growing populations, as long as Fayetteville continues to decrease per capita water consumption, current facilities will be under capacity by 40,316,537 gal daily. Fayetteville is headed on a good track for water consumption sustainability. An additional concern is whether this amount of withdrawal (however low it may appear) is sustainable for Cape Fear River and Glenville Lake. Recharge rates of these primary water sources are unknown.

For a regional water perspective, the LEAM™ outcomes model was used to develop the trends. Residential water use is based on 2000 water use per household in the States of Georgia, North Carolina, and South Carolina. Table J1 lists data on residential consumption. The average U.S. residential consumption from public access systems is 55 percent of the total used (withdrawn). Residential household water consumption for the United States averages about 260 gal/household per day (USGS 2005).



Source: Fayetteville PWC, 2005; LEAM™, 2005

Figure J5. Fayetteville water use gap, current capacity of Glenville Lake and P.O. Hoffer water treatment facilities.

Table J1. Southeast region water consumption.

Area	Households (Millions)	Public Supply (MGD)	Domestic Wells (MGD)	HHD Usage (gal/day)
Georgia	3.006	1,250	110	265
North Carolina	3.132	945	189	226
South Carolina	1.534	566	63.5	244
United States	105.48	43,300	3,590	260

Thermoelectric-power water withdrawals have been affected by the Federal legislation requiring stricter water-quality standards for return flow and by limited water availability in some areas of the United States (U.S. Congress, Amendments to the Federal Pollution Control Act of 1972 and 1977). Consequently, since the 1970s, power plants increasingly were built with or converted to closed-loop cooling systems or air-cooled systems instead of using once-through cooling systems. By 2000, an alternative to once-through cooling was used in about 60 percent of the installed steam-generation capacity in the power plants.

Use of recirculated water for cooling in a closed-loop system reduces the water requirement at the power plant, resulting in reduced water withdrawals. The increasing influence over time of these technologies that require less water can be observed in the historical USGS water-use record. The trend showing the increase, decline, then stabilization of water withdrawals for thermoelectric power from 1950 to 2000 occurred as net electricity generated increased almost 15-fold to 3,450 billion kilowatt-hours

(kWh) during this same period (U.S. Department of Energy, Energy Information Administration, 2003). Overall, significantly less water was required to generate a kilowatt-hour of electricity for 2000. The average gallons of water used to produce 1 kilowatt-hour (gal/kWh) decreased from 63 gal/kWh during 1950 to 21 gal/kWh during 2000 (USGS, 2005). This equates to 6.155 gal/MBtu of electricity; of this, 4.2 gal is fresh water.

Commercial and industrial buildings use 35 percent of the public water supply plus they have there own withdrawals from surface and ground water sources. The other 10 percent of the public water supply is considered losses. Estimates of water consumption for commercial and industrial buildings were based on state-wide average on a square foot basis from USGS and U.S. Census Bureau data. For the state of Georgia, the usage was estimated at 0.268 gal/sq ft/day. This is equal to 0.0035 MGD/acre of commercial/industrial land. For North Carolina, the figure is 0.0098 MGD/acre of commercial/industrial land.

Looking at the entire Fort Bragg region provides a larger picture of the water situation. Figure J6 shows the projected water consumption for residential, commercial, and the electric power industry. As noted above, electrical generation facilities are a large consumer of water, about 21 gal/kWh. As the projection shows, significant growth in water consumption is anticipated. An overall growth of about 38 percent is expected including an even larger growth in residential consumption of about 55 percent. These trends are probably sustainable, but will significantly stress regional water resources.

Addressing Water Quality around Fort Bragg

As previously mentioned, water quality is a major issue facing Fort Bragg and its surrounding region. Water is a limited natural resource and both Fort Bragg and the city of Fayetteville have actively reduced water consumption since 2000 (Figures J3 and J4).

However, due to the soil characteristics of the Sandhills region, Fort Bragg and Fayetteville must protect the quality of what they have. Based on a predictive water quality model—Long-Term Hydrologic Impact Assessment (L-THIA)—the Fort Bragg's seven-county region is estimated to increase water pollutant levels by an average of 3.2 percent (range: 0.2 to 12.3 percent) in 2030 given a population growth rate of 25.6 percent with no changes to current practices (Figure J7).

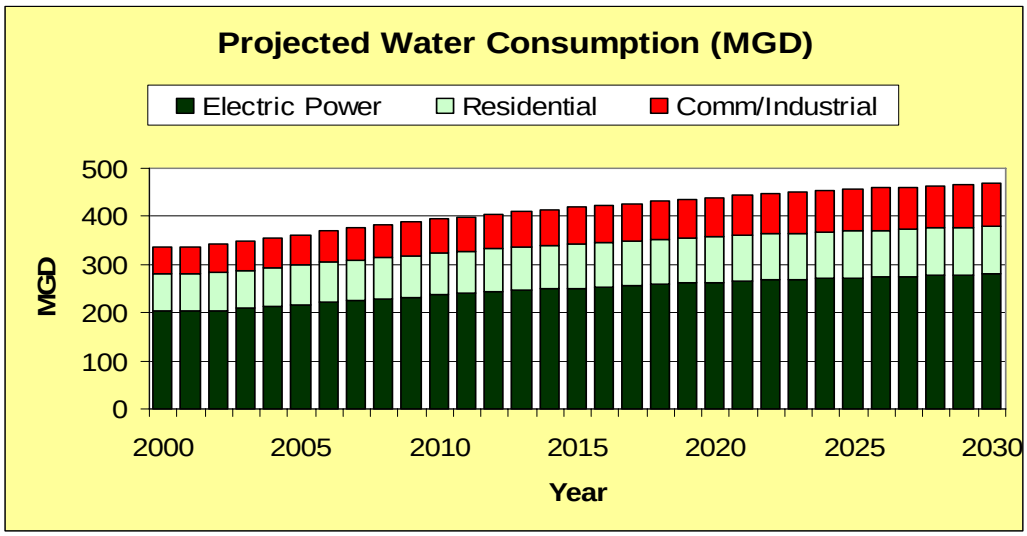
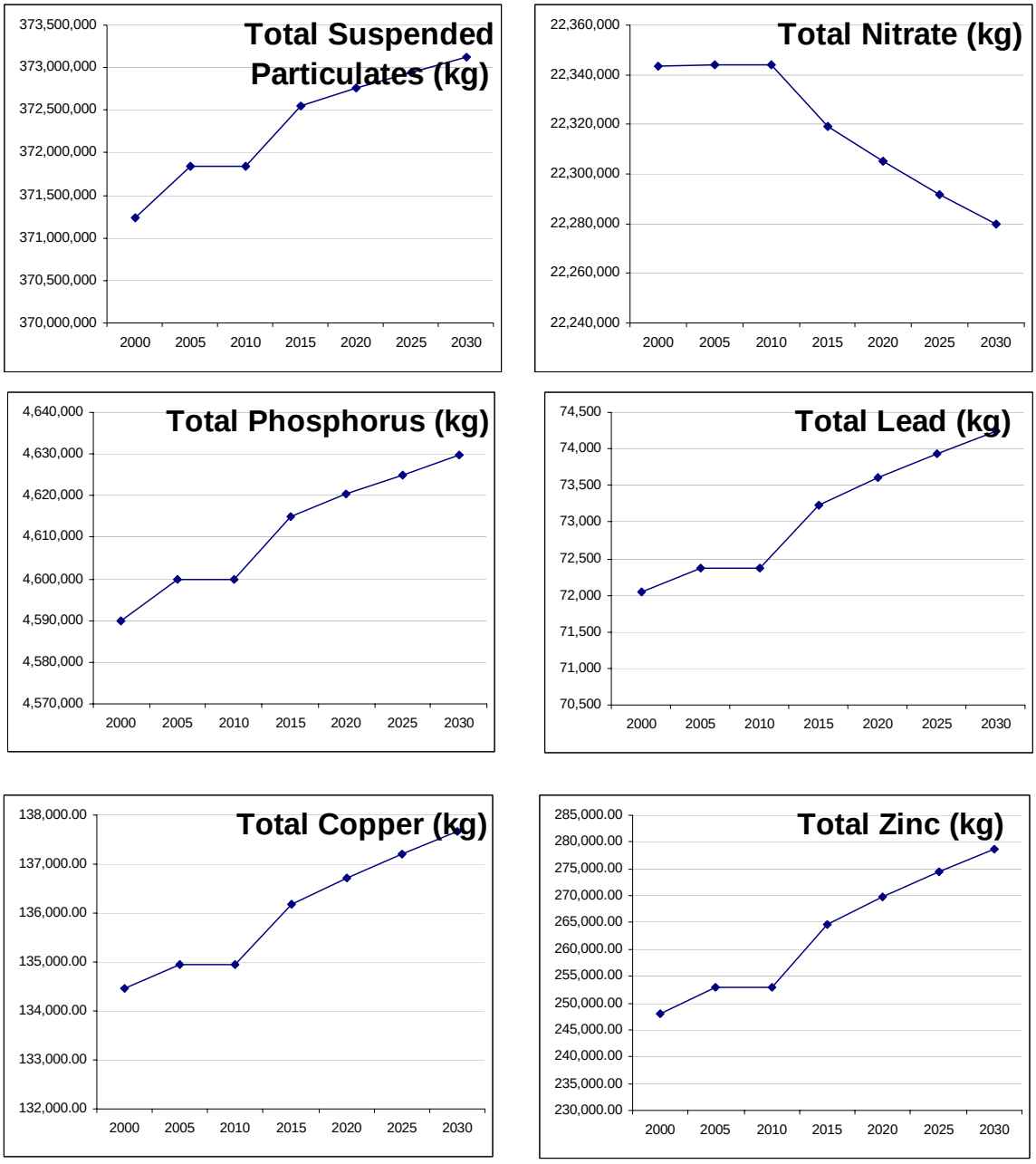


Figure J6. Projected water consumption for the Fort Bragg region.

Unfortunately, neither Fort Bragg nor Fayetteville has set long-term goals addressing run-off pollutant levels. If current trends continue, the increasing pollutants are sure to draw attention from the NCDENR. These water quality trends are estimated based on run-off levels due to land use changes. L-THIA is a run-off model developed to provide a quick assessment of the long-term impacts of urbanization on water quality. L-THIA integrates rainfall and impervious surface to determine stream quantity and quality.

The results can be used to generate community awareness of potential long-term problems and to support physical planning aimed at minimizing disturbance of critical areas. It is an ideal tool to assist in the evaluation of potential effects of land use change and to identify the best location of a particular land use so as to have minimum impact on the natural environment of the area. It is additionally important to note that Fort Bragg is not expected to change the amount of urbanized land on-post. All growth modeled occurs off-post, within the seven counties surrounding Fort Bragg. Regardless of urbanization practices on-post, Fort Bragg is likely to experience significant degradations to its water quality due exclusively to practices within its surrounding communities.



Source: L-THIA, 2005

Figure J7. L-THIA Run-off pollutant levels.

Sustaining water quality on-post and within the local communities requires that decisionmakers, planners, developers, special interests, and politicians perceive their communities as part of a larger system, with the success of any single component dependent on the success of the system. While Fort Bragg and Fayetteville consume less water, their urban growth is degrading water quality significantly with an additional surface run-off of 47,853,173 liters annually carrying pollutants to streams and lakes (L-THIA 2005). Without conscientious urbanization, increasing run-off will

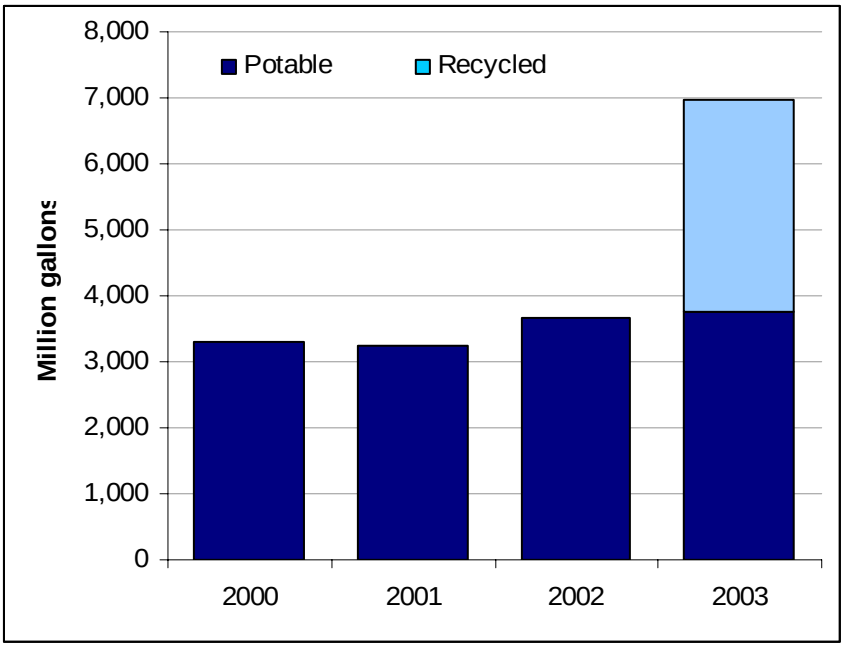
increase pollutant levels of already endangered water sources. Moreover, neither Fort Bragg nor the city of Fayetteville recycles water to supplement available supply and to decrease the total amount of water discharge.

Fort Benning/Columbus Region

Historically, Fort Benning's water was purchased from Columbus Water Works (CWW), a municipally owned water and wastewater utility. In 2004, CWW was issued a notice to proceed on a contract to privatize the installation's water and wastewater systems. CWW is now fully responsible for the operations and maintenance of these systems. However, Fort Benning remains active in promoting water conservation and improved quality of wastewater discharges. Most recently, Fort Benning developed long-term sustainability goals to reduce per capita water usage 50 percent by 2030 and maintain a zero contaminants level in surface water runoff by 2015 (Fort Benning Sustainability Goal-Setting Conference 2005).

Figure J8 depicts a relatively low water consumption level on Fort Benning maintained over several years. Fort Benning's unique characteristic is its use of recycled water. Camp Dresser and McKee (CDM) consulting firm pioneered for Fort Benning several water management technologies that reduce the impact on local water resources. Today, aquifer storage and recovery systems store storm water and treated wastewater in underground "bubbles" where the water can later be removed, increasing water reserves in times of drought and decreasing total drain on natural aquifers. Additionally, composting toilets eliminate the use of water to transport human waste, reducing indoor water use by 20 to 30 percent and providing a small amount of high-quality fertilizer. They consume only 1,825 gal of water per year, compared to 200,000 gal of water per year in a traditional toilet, and without the treatment costs (Fort Benning Sustainability Goal-Setting Conference 2005).

The CWW manages water resources and water reclamation for the Consolidated Government in Columbus. The Board-managed utility is the primary supplier of water and wastewater services for Columbus, as well as other cities and counties in Georgia and Alabama. Fortunately, the Columbus region has an abundant supply of water from the Chattahoochee River. Lake Oliver on the Chattahoochee River is CWW's official water source. CWW's water treatment plant possesses a substantial excess capacity capable of 67 MGD. CWW built the wastewater treatment facility in 1964 and currently operates a modern 42 million gal treatment facility (CWW 2005).



Source: Headquarters Army DUERS Data System (HQRADDS), 2005

Figure J8. Fort Benning water use.

CWW implemented programs over the last decade to optimize its water and wastewater systems as well as demonstrate new technologies for protective water quality and quantity measures such as:

- *CSO Technology Testing*. Multiple flow-through technologies were tested side-by-side to evaluate performance, operations, and costs. Processes that were evaluated included split-stream and floating-gradient hydraulics, coarse screening, vortex solids separations, compressed media filtration, chemical disinfection, and ultraviolet (UV) disinfection.
- *Watershed Monitoring, Modeling and Management*. Comprehensive monitoring of physical, chemical and biological parameters were employed to quantify watershed loads and linkages to water quality indicators. Measurements were used to calibrate the USEPA BASINS Model. Watershed management strategies were developed based on measurement and control technology findings.
- *Source Water Assessment and Protection*. This study looked at the flow corridors and the dynamics of source water supplies to seven drinking water intakes in the Middle Chattahoochee River watershed. Potential contaminant and source inventories were compiled from field surveys. Strategies were developed for providing early warnings of possible contaminant releases, watershed improvement progress monitoring and watershed management.

Yet, monitoring, modeling, and management efforts are not unique to CWW. Through the DoD SEMP Program, an Ecosystem Characterization

and Monitoring Initiative (ECMI) was undertaken at Fort Benning. The purpose and scope of the ECMI report is to describe the long-term baseline ecosystem monitoring plan developed for Fort Benning. In general, the plan characterizes the supply watershed and describes the methods followed for impact area delineation, potential pollutant inventory, susceptibility assessment, and a framework for protection planning.

Findings from the CWW and Fort Benning programs demonstrate that the Chattahoochee River is in compliance with water quality standards. However, its aquatic biology is in the "fair to poor" range believed to result from the impacts of hydroelectric power generation on the river hydrology. Daily bacteria levels are sometimes above recommended criteria and are the result of wet weather runoff from area creeks.

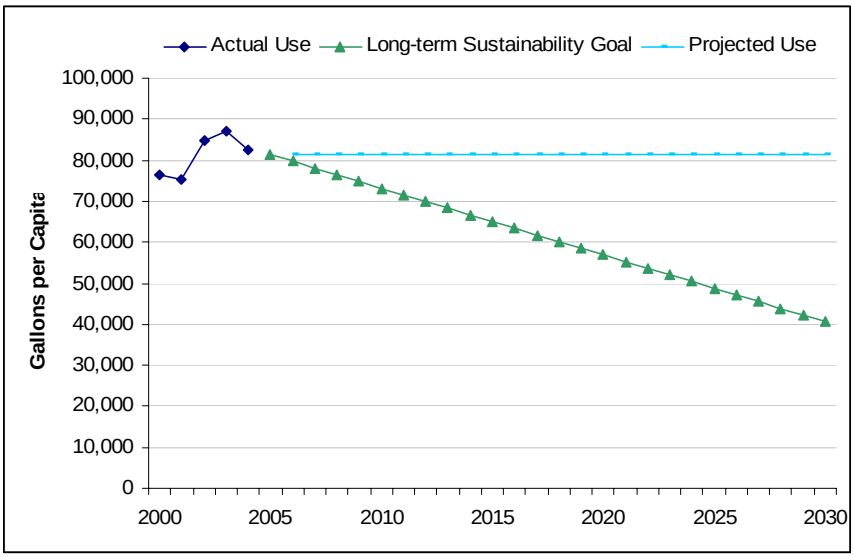
Water quality is a critical concern for Fort Benning primarily due to its inherent land uses. Fort Benning is a major training installation. Most of the land area is undeveloped and is used for military training, weapons ranges, drop zones, and landing zones. There are 63 action firing and non-firing ranges. An average 20,000 troops are in the field daily. There are currently 17,454 hectares (43,128 acres) of mechanized training area out of 46,210 hectares (114,184 acres) of total available training area. In addition, 14,225 hectares (35,149 acres) are established impact areas and 6,866 hectares (16,967 acres) are restricted dud areas. Approximately 5,759 hectares (14,231 acres) of land comprise four cantonment areas. These environmentally stressful activities justify a goal of zero impacts on surface waters for Fort Benning.

Measuring the Gap around Fort Benning

In its recent history, Fort Benning has maintained a per capita water consumption rate of 81,000 gal annually. Thus, it is assumed with no further actions that this rate will continue into the future. However, this is not Fort Benning's goal. To reach its long-term sustainability goal to reduce per capita water usage 50 percent by 2030, Fort Benning must take action. Figure J9 illustrates current consumption rates in relation to Fort Benning's long-term sustainability goal.

Looking at the entire Fort Benning region provides a larger picture of the water situation. Figure J10 shows the projected water consumption for residential, commercial, and the electric power industry. As noted in the discussion about the Fort Bragg region, electrical generation facilities are a large consumer of water, about 21 gal/kWh. This growth in water con-

sumption for electric power occurs where the power plants are located. Currently, there are no major power plants near Fort Benning. As the projection shows, significant growth in total water consumption is expected. An overall growth of about 37 percent is expected including an even larger growth in residential consumption of about 55 percent. These trends are probably sustainable, but will significantly stress regional water resources.



Source: Headquarters Army DUERS Data System (HQRADDS), 2005

Figure J9. Fort Benning water gap.

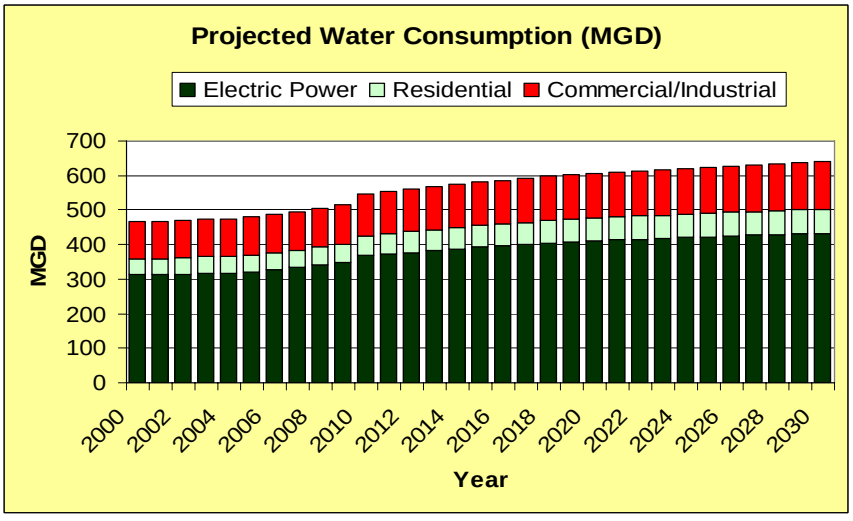


Figure J10. Projected water consumption for the Fort Benning region.

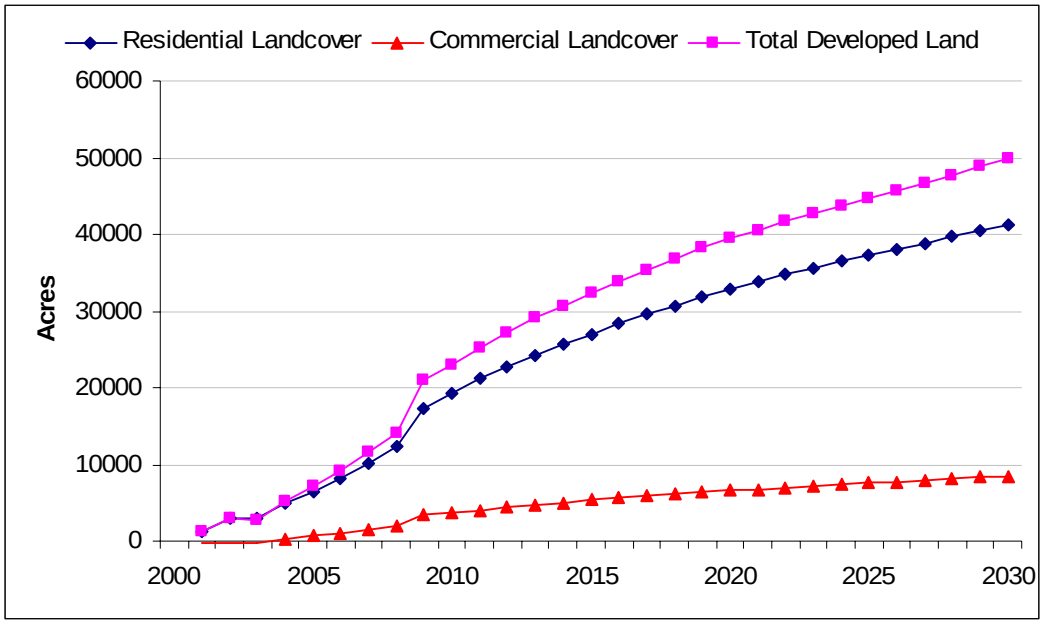
Addressing Water Quality around Fort Benning

Fort Benning is concerned with use of underdeveloped land. Overuse and poor maintenance programs result in deteriorated land areas that produce severe run-off and carry pollutants directly into surface waters. Fort Ben-

ning has already been proactive in redesigning ranges and heavy mechanized training grounds to protect land quality. Without an active program to maintain the installation, severe erosion from forestry practices and intense military training, soil compaction from heavy mechanized training, depletion of vegetative cover and heavy machinery stress on shrubs and trees beneath the forest canopy will continue, leading to the loss of sustainable training land resources at Fort Benning.

Urbanized land area within the eight counties surrounding Fort Benning is expected to increase by 40,980 acres over the next 30 years, based on projections in this study. Accounting for 2005 BRAC recommendations, urbanization will likely increase by 48,305 acres (LEAM™2005) (Figure J11). Previous L-THIA modeling demonstrates that urbanization increases surface water run-off and accelerates problems related to water quality and quantity. However, these problems can be minimized with management actions.

Fort Benning has a Storm Water Pollution Prevention Plan (SWPPP) that provides guidance to control contamination in runoff from transportation and maintenance facilities; reuse, recycling, and disposal activities; and other regulated industrial activities that may be exposed to storm water. It describes and promotes best management practices to reduce storm water pollution. The SWPPP also provides guidance regarding site erosion and sediment control. The SWPPP is an example of how Fort Benning is taking the initiative to direct its future. Unfortunately, the actions have only taken place on-post when in reality, it is what is occurring on-post and within the surrounding communities that direct the future. Fort Benning is but one component within the eight-county region. Its total land area is 181,353 acres or 8.3 percent of the modeled region. Despite Fort Benning's successes, if the region does not implement sustainable practices, both Fort Benning and its region will be in jeopardy.



Source: LEAM™ 2005

Figure J11. Fort Benning regional developed land, accounting for 2005 BRAC recommendations (plus-up of troops).

Appendix K: Housing Gap Analyses

Overall Army Housing Policy and Goals

The Army provides housing support for "accompanied" and "unaccompanied" enlisted service members. Army policy dictates unaccompanied service members in pay grades E1-E6 to be housed on-base in barrack housing. All service members above pay grade E6 shall be housed in family housing on- or off-base as available. Despite policy to house all servicemen with an E6 or lower pay grade on-base, the Army is increasingly allowing larger numbers of unaccompanied junior service members (pay grades E4-E6) to live in the local community. This is preferable in the face of increasing barrack program needs and construction costs. Additionally, surveys reveal junior service members prefer to live off-base. Today, approximately 75 percent of E6 and 27 percent of E5 service members live off-base. Regarding accompanied service members, typically 33 percent are housed on-base (Army Housing 2005).

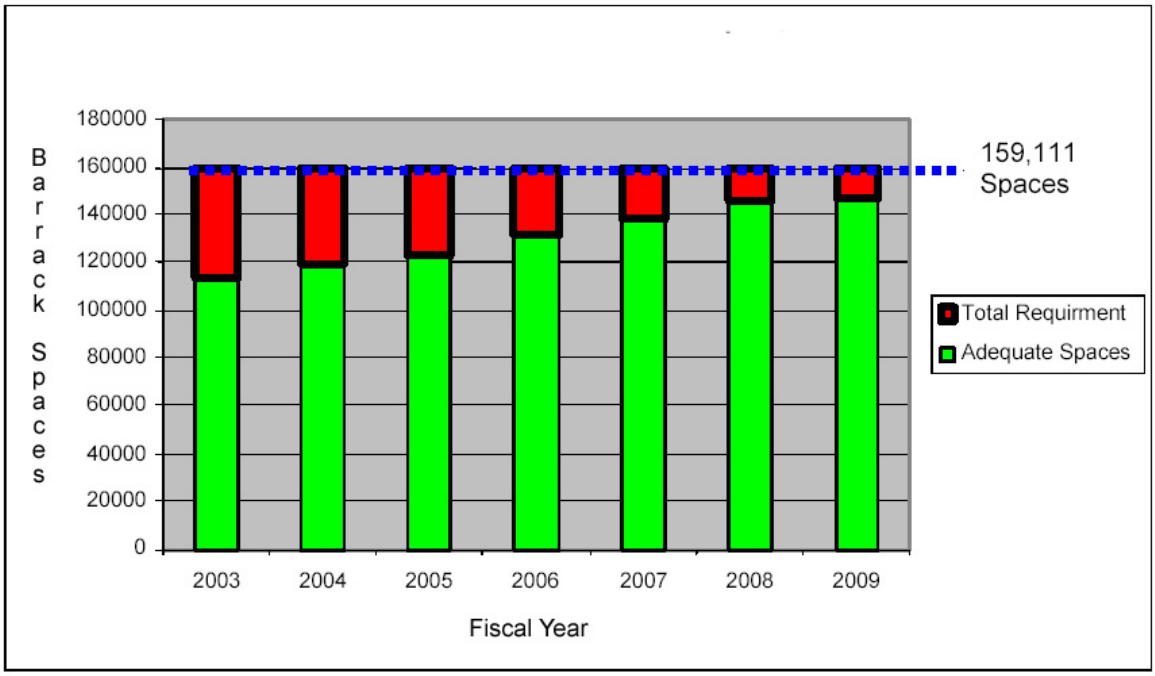
The Secretary of Defense directs housing policy to maximize reliance on off-post housing. Only when the private market demonstrates that it cannot supply sufficient levels of quality housing does the DoD provide housing. According to the Army Facilities Housing Master Plan (AFHMP), the majority of the government-owned and leased housing was constructed between 1950 and 1970 with an average age of 36 years (HQDA 2003). With no direct funding for housing maintenance, the majority of the Army's housing inventory fell out of adequate condition when evaluated against a set of facilities' standards developed and approved by the Army Staff. These standards are part of the Installation Status Report (ISR) that provides ratings for the housing units. In general, an inadequate unit requires a major repair, component upgrade, component replacement, or total upgrade.

In the face of poor housing conditions, the Secretary of Defense set a goal to eliminate inadequate housing by 2007 (HQDA 2003). The Army's Department of housing, not seeing ownership, operation, and maintenance of housing as a core DoD function, adopted privatization as the primary option to meeting the Secretary of Defense's goal as well as overall operational, readiness, and quality of life requirements.

The Army Housing Division separates management into Unaccompanied Personnel Housing (UPH) and Family Housing (FH) branches. Each branch prepares annual master plans that track inventory and set goals. The UPH Army Barracks Master Plan, last updated July 2004, focuses on the modernization of unaccompanied housing in support of the Secretary of Defense's goal to eliminate inadequate barracks. The Master Plan estimates a barrack housing requirement of 159,111 spaces for 136,000 soldiers. As of 2004, 75 percent of the 159,111 spaces were classified as adequate. Available funding provides for 93 percent of the total spaces to be deemed adequate by 2009 (Figure K1).

Both Fort Bragg's and Fort Benning's barracks are scheduled for upgrade in FY2008. Additionally, UPH is currently transitioning to provide a direct source of funding for barrack housing sustainability and maintenance programs.

The AFHMP is a consolidated strategy to sustain safe, attractive, convenient, and affordable housing for service members and their families. The strategy meets the Secretary of Defense's goal of eliminating all inadequate family housing by 2007, through a combination of traditional military construction, increases in the Basic Allowance for Housing (BAH), and privatization of housing units through the RCI program.



Source: UPH Army Barracks Master Plan, 2004

Figure K1. Barracks modernization.

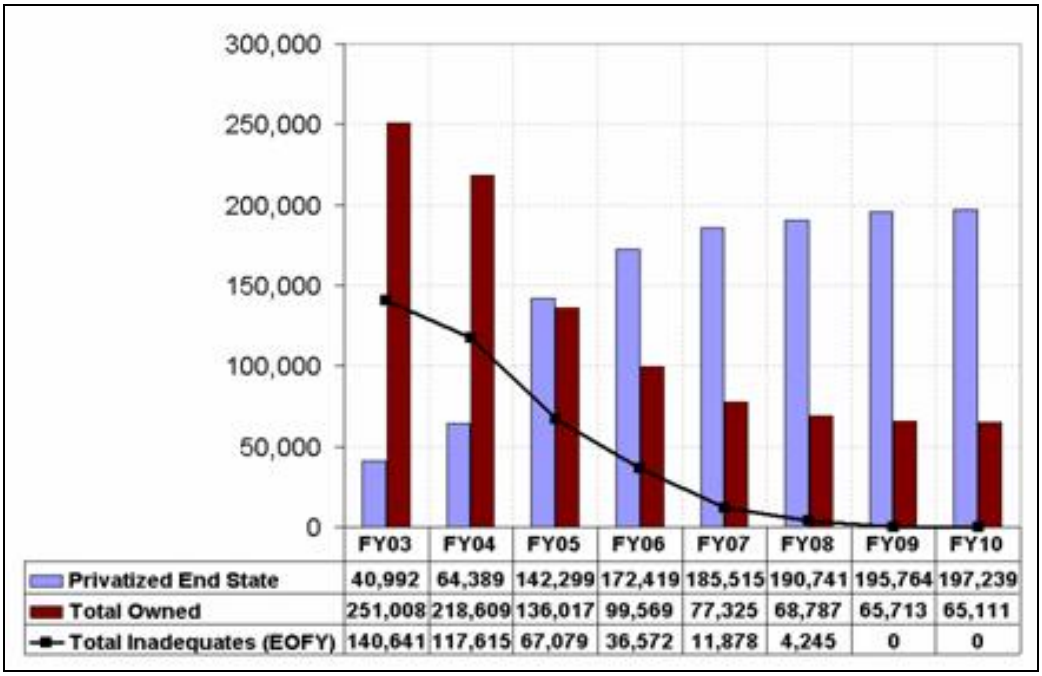
The Army Family Housing inventory for all U.S. installations in FY2004 was 65,540 owned units, 21,324 privatized units, and 5,479 leased units. The 5,479 leased units are commonly known as Section 801 housing. Under provisions of 10 USC 2835, Long Term Leasing of Military Family Housing to be Constructed, the Army leases family housing units from a private sector developer for as long as 20 years. The units are assigned as military housing to service members and their families. This program helps reduce family housing deficits at seven installations where Army families are the most seriously affected by housing shortages. Fort Bragg is one such installation. Fort Bragg leases 250 units under contract from November 1993 through October 2013.

Service members seeking housing off-post receive a BAH in addition to basic pay. Current DoD policy does not mandate that BAH meet all housing costs for service members and their families. If necessary, each member is expected to pay additional money to meet housing costs. However, with efforts focused to reduce inadequate housing, the Secretary of Defense asserted elimination of all out-of-pocket expenses by 2005. As a result, average out-of-pocket expenses have declined from 11.3 percent in 2002 to 7.5 percent in 2003 and down to 3.5 percent as of January 2004. The FY2005 President's Budget Request contained funding to reduce the out-of-pocket expenses to zero in CY2005.

The Army's housing privatization program (RCI) is a recent element of the Army's three-prong effort to eliminate inadequate family housing. It is dedicated to allowing the Army to leverage appropriated housing funds and assets to attract private-sector capital and expertise to construct, repair, maintain, and operate family housing communities. RCI leverages appropriated funds and government assets by entering into long-term partnerships with nationally recognized private sector real estate development and management firms. Figure K2 shows the Army's upgrade and privatization plans from FY03 to FY10.

Fort Bragg/Fayetteville, NC

Fort Bragg has 5,578 privatized family housing units on-post and 250 leased units. The transition to privatized family housing began in FY2002 with $49.4 million in funding. In 2002, Fort Bragg maintained 4,580 family housing units and 250 leased units. Of the 4,580 owned units, 1,223 units were classified as adequate while 3,357 units were classified as inadequate (HQDA 2003). The Army's family housing RCI upgraded the inadequate housing units and added additional units.



	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10
Privatized End State	40,992	64,389	142,299	172,419	185,515	190,741	195,764	197,239
Total Owned	251,008	218,609	136,017	99,569	77,325	68,787	65,713	65,111
Total Inadequates (EOFY)	140,641	117,615	67,079	36,572	11,878	4,245	0	0

300,000
250,000
200,000
150,000
100,000
50,000
0

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10
Privatized End State	40,992	64,389	142,299	172,419	185,515	190,741	195,764	197,239
Total Owned	251,008	218,609	136,017	99,569	77,325	68,787	65,713	65,111
Total Inadequates (EOFY)	140,641	117,615	67,079	36,572	11,878	4,245	0	0

Source: Army Family Housing Master Plan (AFHMP), 2003

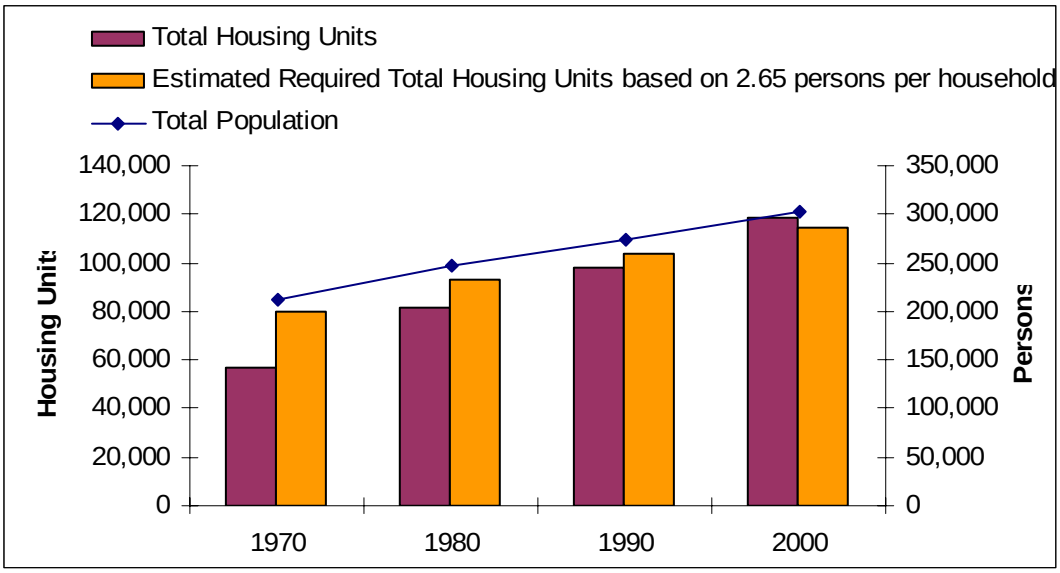
Figure K2. Family housing transition.

For barrack housing through 2004, there are 9,856 adequate and 7,196 inadequate barrack spaces. Scheduled for 2008, Fort Bragg is to receive $749,440 to upgrade 5,348 inadequate spaces, according to the Army Barracks Master Plan (HQDA 2004). After completion, Fort Bragg will have 15,057 available barrack spaces. Because of the continual restructuring of the Army over time, the current barracks inventory at each installation does not necessarily match the validated number of spaces needed to house unaccompanied enlisted service members. This inventory is an estimated number of spaces the Army has identified particular to Fort Bragg.

Together, Fort Bragg can be expected to provide a total 20,735 on-post housing units (barrack and family housing). Given a current active military population of 42,941 personnel, Fort Bragg is capable of housing the expected percentages of personnel on-base. To further promote a scenario of adequate housing availability on-post, 5,828 family units and 15,057 barrack spaces have been deemed adequate by the Army Housing Division for Fort Bragg's sustainability. The Army Housing Division annually compiles housing surveys and reports from each installation to determine housing needs. However, military strategic and economic conditions that influence this plan are constantly changing. Changes to budgets and Army transformation have a significant impact on housing requirements. While this set number of units and barracks may seem adequate, it is unknown if it will meet future needs. It is critical to anticipate Army transformation along with local/regional housing trends to better assess housing sustainability.

The Army's current strategy for Fort Bragg is to maintain the current population and capacities. The 2005 draft of BRAC recommends relocating the 7th Special Forces Group from Fort Bragg to Eglin AFB, Florida and relocating European-based forces to Fort Bragg. This swap of brigades has little impact on the housing needs at Fort Bragg, and thus Army transformation is predicted to have minimal impact on future housing. If Fort Bragg were to receive additional brigades and as a result require additional housing, there is little developable land within the installation boundary to construct the required buildings. Fort Bragg would have to look to Fayetteville to support any additional housing needs. Historically Fayetteville has experienced significant housing shortages.

Figure K3 compares housing growth to population growth in Cumberland County from 1970 through 2000. Despite a 108.4 percent growth in housing compared to a 52.9 percent growth in population from 1970 to 2000, Cumberland County's housing market is still recovering from a housing deficit. The inability of the private market to ensure available community housing for soldiers and their families is what raised a red-flag at Fort Bragg and qualified it for the Section 801 leasing program in 1993. By 2000, the gap was closing and housing construction was catching up with population growth. In fact, given an average household size of 2.65 persons (U.S. Census Bureau 1970–2000), Cumberland county required approximately, 114,325 housing units in 2000 while the market supplied 118,425 total units. Note that "total unit" includes occupied and vacant housing units.



Source: U.S. Bureau of the Census, 1970-2000

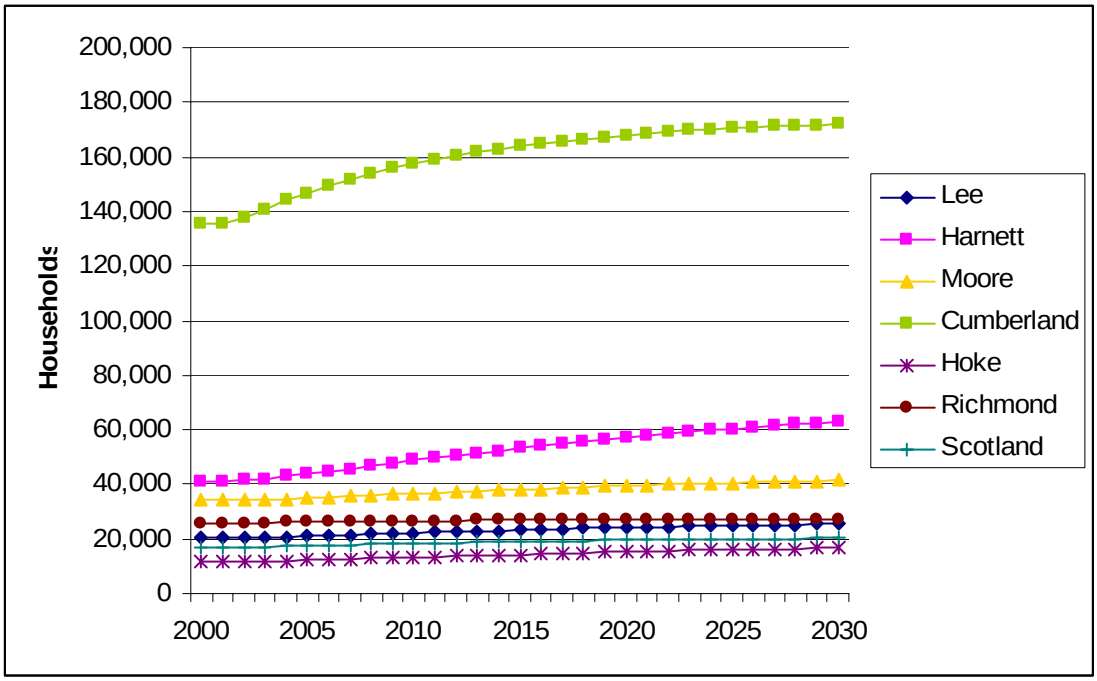
Figure K3. Cumberland County total housing units vs. population, 1970–2000.

Within any community, there is a normal vacancy rate due to an undesirable housing style or condition, or property that is only be seasonally occupied. Extreme vacancy rates can be an indicator of difficulty in obtaining housing (too low) or serious problems in the housing market and surrounding economy (too high). Fort Bragg's local region maintains desirable vacancy rates for owner- and renter-occupied housing units* (SIRRA 2005). Accounting for vacancy rates, a housing deficit still remains in Cumberland County in 2000.

Measuring the Gap

The average annual population growth of the seven-county region surrounding Fort Bragg is expected to increase by 25.6 percent from 2000 to 2030 (LEAM™ 2005). Figure K4 illustrates the impact this places on household growth throughout the Region. The number of households was predicted using LEAM™ modeled land use changes. Given the estimated population for Cumberland County in 2030 (429,535 persons), the county is predicted to need approximately 172,031 housing units (36,452 additional units). This increase in population is comparable to historical population trends.

* The regional homeowner vacancy rate surrounding Fort Bragg is 2.6 percent and desirable percentages range from 2 to 3.5 percent. Regional renter vacancy rate is 10.15 percent and desirable percentages range form 7 to 11.25 percent. Regional values are calculated by averaging vacancy rates of the 7-county sub-region (Source, SIRRA).

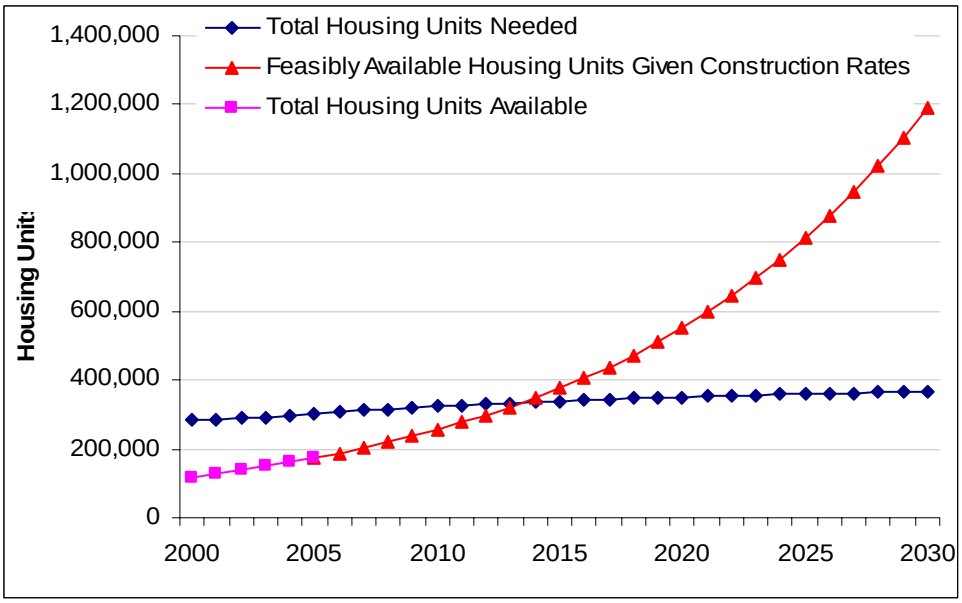


Source: LEAM™ 2005

Figure K4. Predicted household growth, Fort Bragg sub-region.

Average annual construction rates from the U.S. Census indicate the housing supply within the Fort Bragg region is increasing by 108.4 percent annually. This indicates that the region can realistically recover from historical housing deficits and meet the needs of a growing population by 2015 (Figure K5). The predicted numbers of feasible units were calculated using the same housing growth rate that occurred between 1970 and 2000 in Cumberland County—108.4 percent. The housing growth rates between 1970 and 2000 reflect rapid growth in housing construction in response to housing shortages. Housing production will actually taper off slightly from the predications in Figure K5 as market demands are met.

U.S. Census statistics also indicate that owner occupied units are growing faster than rental occupied units. In other words, residents increasingly prefer to own rather than rent housing (Table K-1). The construction market is predicted to eliminate housing deficits surrounding Fort Bragg by 2015 provided that regional construction rates are maintained and that transformation decisions do not change. Dramatically increasing the installation's population would spur another housing shortage in the region. Decisions about future transformation affecting Fort Bragg must take into account the region's housing availability. An additional concern is how housing deficits have affected housing values and overall affordability.



Source: U.S.. Bureau of the Census, 2000-2003; LEAM™ 2005

Figure K5. Predicted housing deficit recovery, Fort Bragg sub-region.

Table K1. Cumberland County housing characteristics.

Cumberland County		1970	1980	1990	2000
	Total housing units	56,816	81,269	98,360	118,425
	Occupied housing units	52,000	74,934	91,500	107,358
	Vacant housing units	4,816	6,335	6,860	11,067
	Vacant for Rent	2,410	3,146	3,343	5,256
	Vacant for Sale	947	1,028	1,190	2,004
	Rental Occupied	23,280	31,258	38,699	43,610
	Owner Occupied	28,719	45,761	52,801	63,748
	% Vacant for Rent	0.50	0.50	0.49	0.47
	%Vacant for Sale	0.20	0.16	0.17	0.18
	% Rental Occupied	0.45	0.42	0.42	0.41
	% Owner Occupied	0.55	0.61	0.58	0.59
	Rental Vacancy Rate	9.38	9.14	7.95	10.76
	Owner Vacancy Rate	3.19	2.20	2.20	3.05
	Housing Growth Rate, 1970-2000			108.4	%
	Occupied Housing Growth Rate, 1970-2000			106.5	%
	Population Growth Rate, 1970-2000			52.9	%
Source: U.S. Bureau of the Census, 1970-2000					

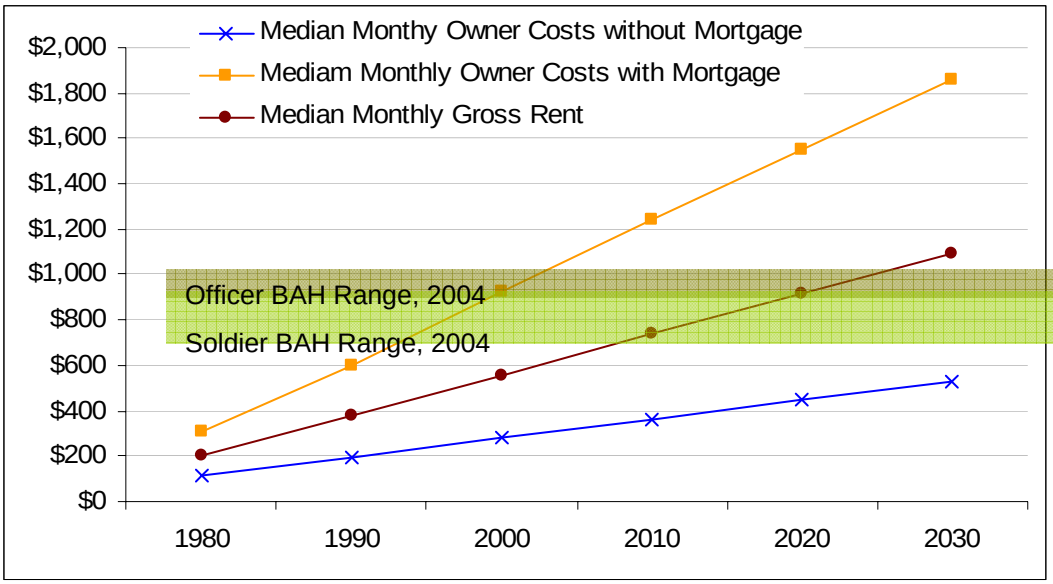
Addressing Housing Affordability

In 2000, the median value of owner-occupied housing units for the City of Fayetteville was $89,300 with an upper value quartile of $125,200. In terms of rental units, the median gross rent (including utilities) was $585 (U.S. Bureau of the Census 1970–2000). According to the National Association of Realtors, housing costs in 2005 for Fayetteville average $103,182; Cumberland County averages $95,226; and North Carolina has an average of $83,172 (NAR 2005). For Fayetteville to gain over $10,000 in housing value over 5 years is a significant jump in housing costs.

From 1990 to 2003, The U.S. Census Bureau has documented the value of new construction through their housing permits database. In the Fort Bragg region, the cost of new construction verifies an increasing housing value for Fayetteville. The national average of new construction in 2003 was $108,732 per unit. Within Cumberland County, the average cost was $117,727 per unit. Comparatively, in 1990, the national average cost of new construction was $57,516 per unit while in Cumberland County it was $50,742 per unit. As housing construction continues to maintain a higher rate to keep pace with population growth, housing values surrounding Fort Bragg are exploding above national averages. These increasing values result in an increasing BAH from the Army. As the Army aims to eliminate out-of-pocket expenses, the cost of housing for the Army at Fort Bragg is certain to increase.

The BAH is set by the Army Housing office based on the overall cost of living in the specified region (i.e., ZIP code). The trends in the cost of housing within the local community are an indication of the cost of housing incurred by the Army.

Figure K6 depicts median monthly housing cost for owner and rental housing units within Cumberland County. Data for 1980, 1990, and 2000 were reported by the U.S. Census Bureau. 2010, 2020, and 2030 estimates were predicted using linear regression. BAH during 2004 for Commissioned Officers (pay-grade O-3) was $917 per month without dependants and $1,035 per month with dependants. These are illustrated in Figure K6 with brown shading. Enlisted service members (pay-grade E-6) receive $777 per month without dependants and $957 per month with dependants (HQDA 2005). These are illustrated in Figure K6 with green shading. The BAH can be expected to nearly double for troops assigned to Fort Bragg by 2030.



Source: U.S. Census Bureau, 1980-2000; HQDA, 2005

Figure K6. Housing costs in Cumberland County.

Fort Bragg must continue to work with its private partners to manage housing availability and ensure affordable costs to maintain long-term sustainability. Given the local region's expected vacancy rates and high housing production rates, the housing shortages are disappearing. However, it is at the expense of housing affordability.

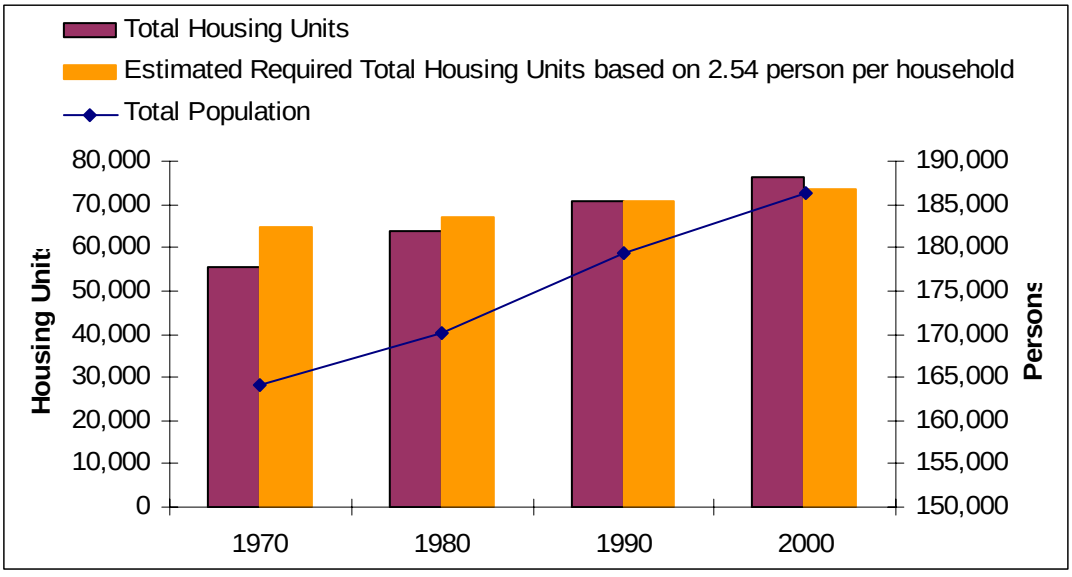
Fort Benning/Columbus, GA

Like Fort Bragg, Fort Benning combats housing deficits and scarcity of developable land within the Cantonment area. As of 2004, Fort Benning maintains 2,925 adequate and 1,070 inadequate barrack spaces for a total of 3,995 spaces. For 2008, Fort Benning is scheduled to receive $51,565 to upgrade 526 inadequate spaces (HQDA 2004). This will leave 3,451 available barrack spaces on Fort Benning. This is a decrease in the total number of available spaces at Fort Benning. The Army Barracks Master Plan estimates required spaces on-post at 3,439. As stated previously, because of the continual restructuring of the Army over time, this is simply an estimated number of needed spaces. In terms of family housing, Fort Benning maintains 255 adequate and 3,800 inadequate for a total of 4,055 units. RCI was initiated in April 2004 with $57 million invested to privatize all 4,055 units by January 2006. Together, this will result in an estimated end-state of 7,506 total on-post housing units available at Fort Benning.

Given Fort Benning's current active population of 20,798 military personnel, it is possible to imagine 7,506 housing spaces accommodating the typical on-post percentages. However, the 2005 draft of BRAC recommends Fort Benning to receive the Armor Center and School from Fort Knox, KY and the 81st RRC Equipment Concentration Site from Fort Gillem while losing the Drill Sergeant School. This results in an estimated gain of 3,662 military personnel, 2,000 civilians/contractors, and respective families between 2006 and 2011 at Fort Benning.

Figure K7 shows that housing construction is growing faster than population in Muscogee County. Yet in 2000, Muscogee County retained a housing deficit. Accounting for an average 8 percent vacancy rate of the total housing units, Muscogee County offered approximately 70,000 occupied units. The needs of the County were over 73,000 units.

Fort Benning's local region maintains unsustainably low vacancy rates for both owner- and renter-occupied units*. This indicates that housing shortages are at an unstable rate and difficulty for residents to obtain housing is mounting.



Source: U.S. Bureau of the Census, 1970-2000

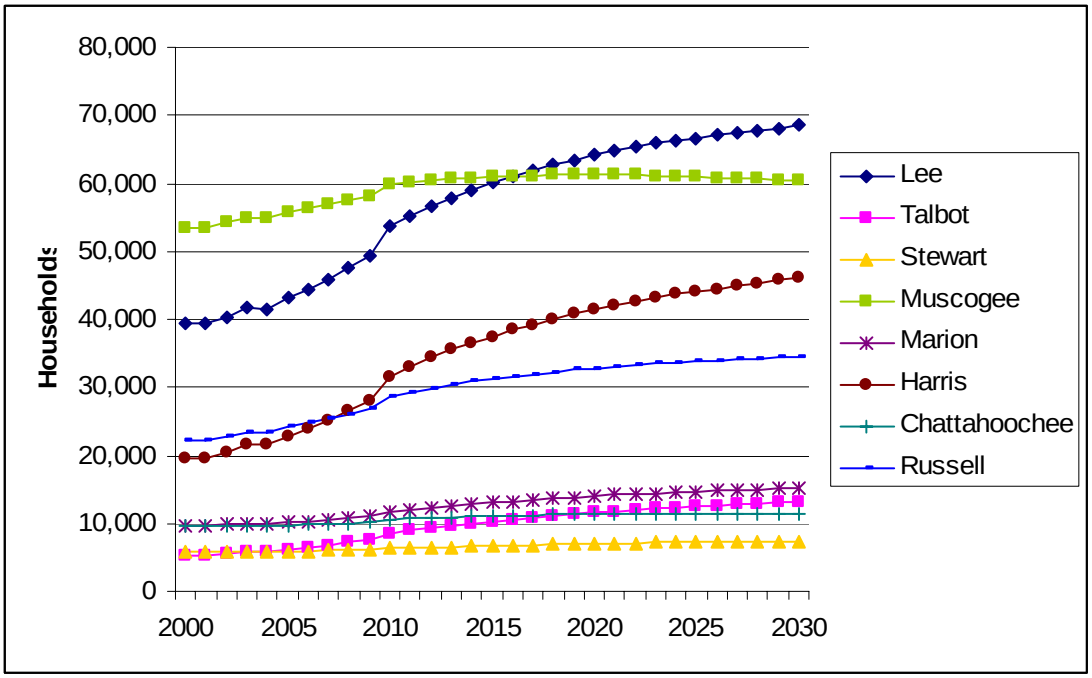
Figure K7. Muscogee County total housing units vs. population, 1970-2000.

* The regional homeowner vacancy rate surrounding Fort Benning is 1.87 percent and desirable percentages range from 2 to 3.5 percent. Regional renter vacancy rate is 6.74 percent and desirable percentages range form 7 to 11.25 percent. Regional values are calculated by averaging vacancy rates of the 8-county sub-region (Source: SIRRA).

Measuring the Gap

Region-wide, Fort Benning is predicted to gain an additional 91,747 housing units over the next 30 years. The largest growth is expected to occur in Lee County, AL (29,184 persons) and Harris County, GA (26,622 persons) (LEAM™ 2005). Figure K8 shows that in 2000 Muscogee County (home to Fort Benning) held 32.3 percent of the regional housing—more than any other regional county. However, it is only expected to gain 8.7 percent of the regional housing growth. LEAM™ modeling indicates that Muscogee County is approaching its developmental limits and growth is expanding in neighboring counties—particularly in counties north of the installation.

Lee County is located northwest of Muscogee County and according to the 2000 U.S. Census and the National Association of Realtors 2005 data, has a positive housing market outlook. Average home prices and family incomes are above Alabama averages, but competitive with national averages. Lee County's average home value and family income are $140,215 and $43,584 respectively. Comparatively, Alabama and U.S. home values average $113,627 and $173.585 and family incomes average $37,086 in Alabama and $40,591 in the United States.



Source: LEAM™ 2005

Figure K8. Predicted household growth, Fort Benning sub-region.

Harris County, GA has slightly lower housing values and family incomes compared to Lee County. Historically, neither county has experienced the projected rapid population growth (which would nearly double population by 2030). Luckily, in 2000, the U.S. Census reported a housing surplus in Lee and Harris Counties—giving each county some leeway in keeping up with construction demands. Statistics also indicate a high percentage of rental units within the counties—36 percent average versus 31 percent in the United States and 23 percent in Alabama. Army housing trends reveal that soldiers increasingly prefer to own rather than rent housing

Fort Benning is set for dramatic increases in population—spurring rapid housing construction within the region. Thus, it is critical that adjacent counties involve themselves in these changes and begin to plan for the influx of people. To ensure maximum sustainability, new housing should be convenient to the installation (minimizing commute times) and supportive of soldiers and their families preferences.

Fort Benning must aggressively focus on housing availability for long-term sustainability. U.S. Census housing data indicates steady housing production rates. If Fort Benning is to meet the housing needs of its soldiers, these rates must increase. Simply maintaining business as usual will not sustain Fort Benning

Addressing Housing Affordability

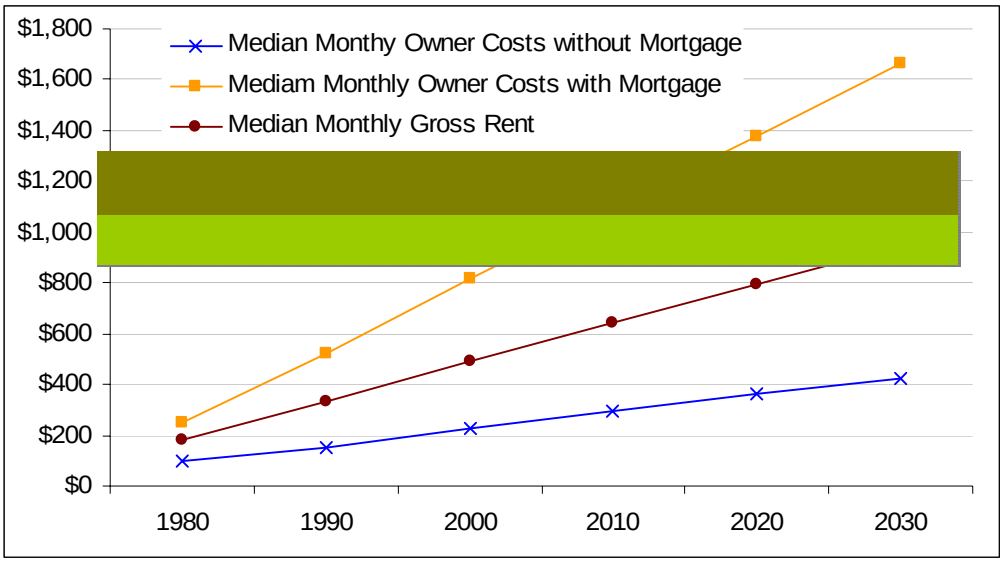
Taking a closer look into local housing affordability, local values in general are not increasing significantly. In fact, they are falling further behind national averages. According to the National Association of Realtors, the 2005 national average housing value is $121,000. For the City of Columbus, the average value is $90,500, values average $78,383 for Muscogee County, and $110,910 for the state of Georgia. Phenix City and Alabama are even lower with average values of $55, 877 for the City, $49,661 in Russell County, and $62,539 in the state of Alabama. Comparatively, in 2000, the U.S. Census reported a median housing value of $84,100 (upper quartile value of $120,500) and a gross rent including utilities as $500 per month for the City of Columbus. This is an approximate difference of $6,400 over 5 years. In Alabama, 2000 values had similar changes. Gross rents with utilities averaged $430 per month in both Phenix City and Russell County.

New construction costs (as reported by the U.S. Census) in 1990 were $50,956 per unit in Muscogee County, $42,787 per unit in Russell County

and $57,561 per unit nationally. In 2003, new construction costs were $89,442 per unit, $82,829 per unit and $108,732 per unit respectively. The cost of new construction in Muscogee and Russell counties is not rising as quickly as the national average. Overall, housing values surrounding Fort Benning are not increasing.

The slow rise of property values surrounding Fort Benning favors Army BAH housing expenditures. Figure K9 indicates that the BAH will increase only slightly by 2030. BAH for 2004 report Commissioned Officers (pay-grade O-3) receive $1,069 per month without dependants and $1,318 per month with dependants. Enlisted service members (pay-grade E-6) receive $831 per month without dependants and $1,126 per month with dependants (HQDA 2005). These are illustrated in Figure K9 with brown and green shading respectively. In 2004, out-of-pocket housing expenses at Fort Benning were zero. Unlike at Fort Bragg where BAH quickly fall behind current housing values, Fort Benning is meeting the Secretary of Defense's sustainability goal of zero out-of-pocket expenses.

Army transformation are expected to put a major strain on Fort Benning's regional housing market. As new troops arrive and demand increases, the construction market will inevitably respond. However, as seen at Fort Bragg, increased production rates drive costs up. Ideally, Fort Benning will start working with its private partners to manage housing availability and ensure affordable costs before the majority of additional troops arrive in 2009.



Source: U.S. Census Bureau, 1980-2000; Army Housing, 2005

Figure K9. Housing costs in Muscogee County.

Appendix L: Education Gap Analyses

Education Availability

A significant element of family readiness is an educational system that provides a quality education to military children. It must be able to recognize the needs of students and respond to situations where the military parent is deployed to armed conflict or otherwise. Children are affected by the absence of a parent and experience even higher levels of stress when their military parent is in a war zone. The military member deployed to that dangerous place cannot afford to be distracted by the worry that his or her child is not receiving a quality education. "Addressing the needs of these children, their classmates, and their parents is imperative to lowering the overall family stress level and to achieving an appropriate level of family readiness. But it does not come without cost to the local school system." (NMFA 2005)

Although the DoD often maintains school districts for those children living on-base, approximately 80 percent of military children attend school in a local educational agency (LEA) (NMFA 2005). These agencies or school districts follow the requirements of their states for enrollment, testing, and graduation requirements. In most school districts, operating funds are generated by state and local taxes. The presence of a Federal military activity in a school district increases enrollment yet reduces the tax base by the removal of property from the tax rolls. LEAs have three main sources of revenue for each student: state aid, local taxes on homes, and local taxes on businesses. When businesses are located on Federally connected land, they are exempt from local taxes. In the case of the military, the soldiers and Sailors Relief Act exempts military personnel from paying certain local personal property taxes and state income taxes. Businesses located on a military post with exclusive jurisdiction are also exempt from paying commercial property tax and purchases are tax free. For the LEA this means a loss of about 25 percent of its revenue.

To compensate LEAs for the loss of tax revenue due to the presence of a Federal activity or Federally-connected students, the U.S. Department of Education (DoE) provides funding through the Impact Aid program. Impact Aid provides vital operating funds for affected school districts; however, Congress has recognized the funding is not enough to support the additional burden placed on LEAs educating large numbers of military

children. Thus since 1991, Congress has provided a Supplement to Impact Aid. The FY2005 budget provides $30 million to the DoD Supplement to Impact Aid. This funding is divided among school districts in which military children make up at least 20 percent of the enrollment—the so called "heavily-impacted" districts.

LEAs with large enrollments of military students exceedingly face challenges associated with base closures and realignments, deteriorating facilities, and inadequate Impact Aid funding. The Army's goal is to provide military children in LEAs with the level of educational opportunity available in neighboring, non-impacted school districts and in schools operated by the DoD Education Activity (DoDEA).

DoDEA serves the needs of military children living on-post. DoDEA encompasses two divisions, DoD Dependents Schools (DoDDS) for overseas installations and Domestic Dependent Elementary and Secondary Schools (DDESS) for installations in CONUS, Puerto Rico, and Cuba. DDESS operates school districts in seven states (Georgia, Alabama, Kentucky, North Carolina, South Carolina, New York, and Virginia). All schools within DoDEA are fully accredited by U.S. accreditation agencies. The DoDEA instructional program provides a comprehensive pre-kindergarten through 12th grade curriculum that is competitive with that of any school system in the United States. DoDEA maintains a high school graduation rate of approximately 97 percent compared to national averages of 70 percent (DoDEA 2005).

The Army recognizes that it is easier to provide for education when there are resources from the surrounding community to build on. The Army has led the DoD in hiring fulltime school liaison officers at all installation locations. These liaisons aid in providing additional counseling and other resources to support children during the deployment of their parents and frequent permanent change of station moves. Through the Education Transition Study Memorandum of Agreement (1999), the military education focus is officially shifting to nurturing relationships between civilian institutions and military institutions to ensure swift implementation of agreements for Army personnel and their families.

Partnerships strengthen the educational system, yet, two factors significantly impact educational resources. The first is Army transformation. As the DoD plans to bring service members and families back from overseas and the BRAC Commission deliberates over DoD's list of installations rec-

ommended for realignment and closure, school districts must begin planning on how to handle the enrollment changes that could occur. In the case of shifts in troop populations, community members at receiving installations are concerned that existing facilities and programs may be overwhelmed by the increased population. Schools generally top the list of military families' concerns. Families who are already at the installations, as well as those who may be moving, worry that overcrowding will affect the quality of education provided to their children (NMFA 2005).

As currently designed, the DoDEA's Impact Aid program is not responsive to sudden increases in school population. Funding for the current school year is provided based on the student count made during the previous school year. Therefore, it will usually be 2 years following the arrival of the additional students before the school district receives the Impact Aid payment that includes the funding for those students. Impact Aid is also designed to support operating costs and not fund large construction projects, which means local school districts needing new school buildings because of an influx of military students must look for other financing options. It is also important to remember that Impact Aid is not forward funded. The funding it receives in the annual appropriation is for that school year, not the coming year. If Congress is delayed in passing an appropriations bill, school districts can face temporary shortfalls as they wait for their Impact Aid payments. These shortfalls will have an even greater impact if the district is also trying to accommodate growing enrollments.

The second impact stems from the Army's housing privatization initiative. The way that the privatization of military housing is handled dictates whether school districts continue to receive necessary educational funding and whether districts can prepare for changes in enrollment caused by population shifts on installations. Concerns as they relate to the privatization of family housing and education include whether or not land is kept under Federal ownership—so the military children are weighted as living on-base in Impact Aid payment calculations—and the timing of privatization construction meshing with the LEA's construction planning so that local school district facilities will meet the needs of transformations as they occur.

It is imperative that community leaders—especially local school district administrators—are consulted early in transformation discussions due to the effects that military transformation and privatization of military housing can have on school funding and facility needs. Close cooperation be-

tween military and community leaders will help to ensure that the effects of transformation and privatization on educational facilities and services can be considered in time to address potential areas of concern.

Fort Bragg/Fayetteville, NC

School-aged children associated with the military stationed at Fort Bragg heavily impact its LEA—Cumberland County School District. For the 2004/2005 school year, 16,312 of Cumberland County Schools' 53,399 students were military-connected. In other words, children of Fort Bragg's enlisted personnel compose over 30 percent of Cumberland County's total school enrollment (Cumberland County School District 2005)

On-post, Fort Bragg maintains nine DDESS schools.* These schools educate all pre-kindergarten through ninth grade children living within Fort Bragg's installation boundary with the exception of a minimal number of children who are home schooled or whose parents prefer that they attend the local schools. Total enrollment on Fort Bragg is approximately 4,300 students (DDESS 2005).

Fort Bragg's on-post schools operate at capacity. Additionally, one installation school (Irwin) is on DoDEA's replacement list, and two others are in poor condition. On-post educational facilities are in poor condition, which is not unlike many DDESS schools who have accumulated a backlog in repair and maintenance—the result of years of unrealistic budgeting and diversion of funds toward other priorities (DDESS 2005).

Despite these shortcomings, parents of children enrolled in Fort Bragg's school system rate the schools highly. They express a preference for the quality of teachers (100 percent certified in DDESS compared to 350 uncertified in LEA), a continually dropping student/teacher ratio (14.2:1 on-base and in LEA compared to a national average of 22:1); and the test scores of DDESS students that persistently outscore LEA students. Moreover, schools on-post are effectively connected to the LEA. Fort Bragg DDESS schools maintain a synchronized calendar and consistent curriculum with LEAs. This is particularly beneficial to high school students who must transition to the LEA. In 2005, The Military Child Education Coalition's Board of Directors recognized the beneficial partnership between

* Fort Bragg Schools include: Bowley Elementary School (PK-4), Butner Elementary School (PK-4), Devers Elementary School (PK-4), Holbrook Elementary School (PK-4), McNair Elementary School (PK-4), Murray Elementary School (PK-4), Pope Elementary School (PK-4), Irwin Middle School (5-6), and Albritton Junior High School (7-9).

Fort Bragg and Cumberland County Public Schools. Fort Bragg fosters a positive learning environment and parents value the benefits DDESS provides to better enable students to cope with deployments.

The short-term sustainability of Fort Bragg's educational system would benefit from the continued push from DoDEA to increase funding for construction, renovation, and maintenance needs. Assessment of Fort Bragg's long-term sustainability involves a closer look at the LEA and changes in educational requirements due to Army transformation.

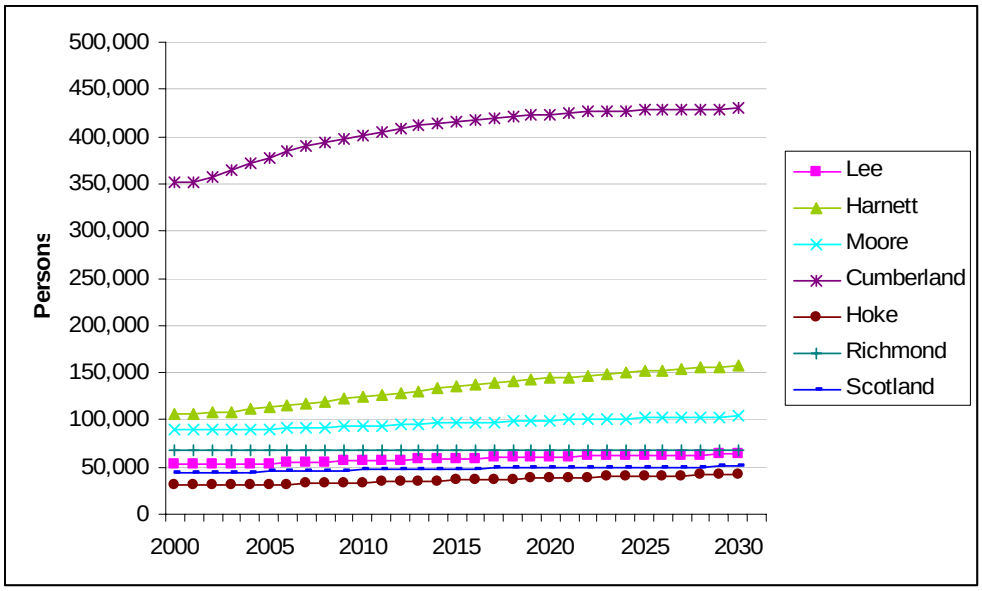
Cumberland County schools continually strive for higher achievement scores and quality staff members. In 2004, the district initiated a program connection between two local high schools and Fayetteville State University and Fayetteville Technical Community College (Cumberland County School District 2005). The program allows high school students to complete high school requirements as well as earn college credits. The district has also established a professional development program to help teachers become certified by the National Board for Professional Teaching Standards. In 2004, 28 teachers were certified. This brings the total number of National Board Certified teachers to 159 of 3,273 (Cumberland County School District 2005). Quality programs and teachers lead to a quality school system. Cumberland County schools progress in these areas each year. Shortcomings arise in the ability of Cumberland County schools to avoid exceeding facility capacities. In 2005 total student enrollment was 53,399 students while total facility capacity was 54,426 students. To meet these needs, during 2005 Cumberland County School District completed classroom additions to two elementary schools, added a media center to another elementary school, and began classroom additions to six additional elementary schools. These additions were funded through state and local bonds (Cumberland County School District 2005).

Measuring the Gap

Since 1992, the number of students in Cumberland County schools has increased by 8,000 and the number of teachers by 977. Population increases, class size reduction initiatives, and additional programs affect facility needs. The 2004 Facility Needs Audit identified up to $170 million in facility needs. Simply put, Cumberland County does not have the operating budget to meet these needs.

Moreover, population projections for the seven-county region surrounding Fort Bragg* estimate an increase in population of 162,677 persons. This includes 77,028 in Cumberland County alone (Figure L1). Given 2000 U.S. Census data, Fayetteville averages 21 percent of its population between the ages of 5 and 18 years. Assuming this to be true of the entire Fort Bragg region, nearly 34,390 additional children (ages 5 to 18 years) will live in the Fort Bragg region by 2030. This averages 1,146 students per year. Cumberland County alone can expect an additional 16,176 students by 2030 (540 student annual average) (LEAM™ 2005).

The 2005 issue of BRAC has no impact on current student enrollments at Fort Bragg (BRAC 2005). Enrollment in Fort Bragg's DDESS schools are not expected to dramatically shift. However, Fort Bragg's recent privatization of housing is having significant impacts. Due to land scarcity, several hundred homes were selected to be built on a tract of installation land located approximately 15 miles from the main installation, other military housing, and the DoD schools. The land is located in Harnett County, which ranks 115th out of the state's 117 school districts in terms of per pupil expenditures. It is still unclear which school district will ultimately be responsible for educating military children living in the new housing, whether the district will have the necessary resources to offer a quality education, or what resources will be needed by either school system.



Source: LEAM™ 2005

Figure L1. Population increase by county for the Fort Bragg sub-region.

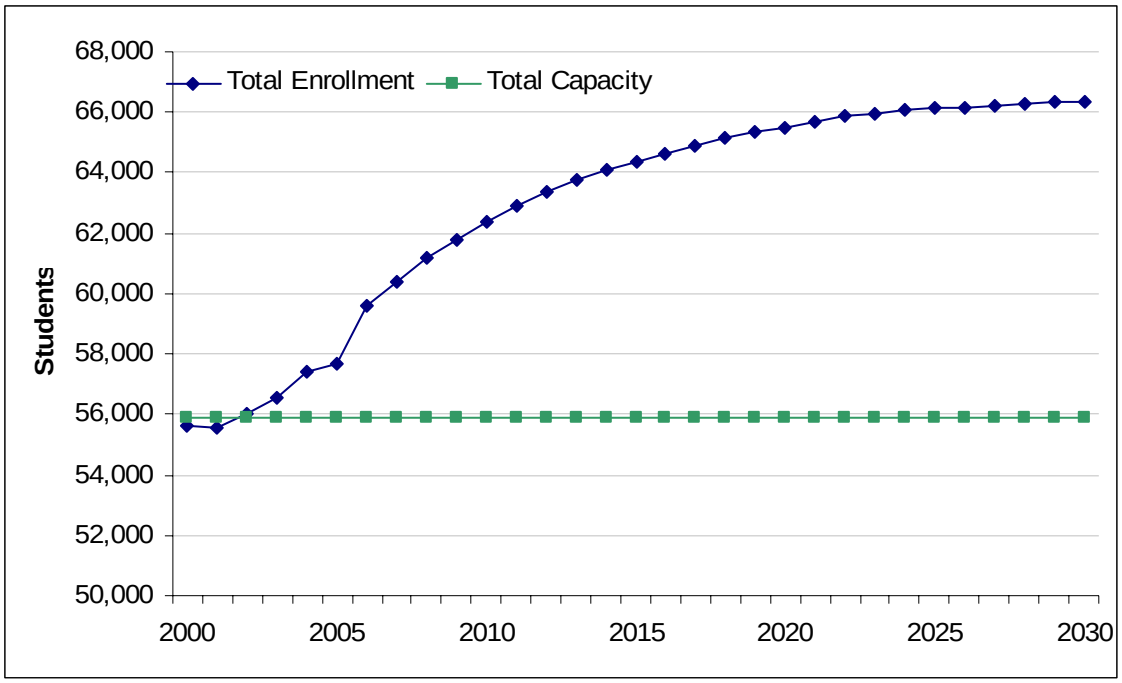
* The Fort Bragg Region includes Cumberland, Harnett, Hoke, Lee, Moore, Richmond, and Scotland counties. 162,677 population increase derived from a 25.6 percent increase in population.

DoDEA master planning recommends the transfer of DDESS schools on Fort Bragg to Cumberland County School District. In this agreement, the DoD would remain responsible for building maintenance, operation, and improvements. The DoD would also maintain the pre-kindergarten program. Fort Bragg school district additionally recommends that a high school be built on-post. While the recommendation to transfer all schools with use of facilities is consistent with the DoD's guiding principles, a situation unique to North Carolina will require additional compensation for adequate special education services. North Carolina places a state funding cap on special education costs that limits participation to 12.5 percent. Military personnel who have dependents eligible for special education services often seek assignments located near special education programs and facilities. In some instances, those special education programs and facilities are provided by LEAs. In other instances, such as Fort Bragg, the special education programs and facilities are provided by DDESS. Under this recommendation, DoDEA will have to compensate the LEA fully for any extra costs (beyond the 12.5 percent cap) due to the extraordinary high percent of special education children receiving services through DDESS.

The transfer of DDESS schools to Cumberland County School District would place an extra burden on an already low wealth school district. Cumberland County schools spend $6,638 per pupil each year compared to a national average of $6,911 per pupil (Cumberland County School District 2005). The district's operating budget is limited.

Figure L2 illustrates the predicted 2000-2030 school enrollments for the Fort Bragg Region and Fort Bragg DDESS school systems. Neither DDESS nor local school systems could accommodate an increase in students due to military plus-ups at Fort Bragg. Conversely, if students were to leave—revoking the LEA's "high impact" Supplement to Impact Aid—district income would drop significantly and the Cumberland County School District would suddenly find itself unaccustomed to the lower available funds and over supplied with resources.

Although Fort Bragg's on-post schools have no enrollment concerns, school dilemmas concerning the LEAs may be looming if Fort Bragg does not work to foster quality educational opportunities within the LEAs.



Source: LEAM™ 2005; Cumberland County School District, 2005; DoDEA, 2005

Figure L2. Predicted School Enrollments, Fort Bragg ("Total" = Fort Bragg DDESS + Cumberland County School District).

Fort Benning/Columbus, GA

Fort Benning maintains seven DDESS schools* educating approximately 2,400 students in pre-kindergarten through eighth grades. Fort Benning DDESS schools maintain a student-teacher ratio of 19:1 (National average is 22:1). Parents of Fort Benning DDESS students value Fort Benning's expanded use of technology in the classroom, maintenance of after-school programs aligned with base activities, and highly qualified teacher corps not duplicated in the LEA.

Fort Benning's LEAs primarily include Muscogee County and Chattahoochee County school districts in Georgia and to a lesser degree Russell and Lee County school districts in Alabama. Muscogee County is the leading LEA—with 20 percent of its total enrollment from Fort Benning's military children classifying it as a "highly impacted" LEA. For the 2003-2004 school year, Muscogee County School district enrolled 32,747 students of which 6,548 were military students. Chattahoochee County schools enroll a more conservative number of 422 students. Of these, 93 (nearly 15 per-

* Fort Benning Schools include: Loyd Elementary School (PK-5), McBride Elementary School (PK-3), Stowers Elementary School (PK-5), White Elementary School (PK-5), Wilson Elementary School (PK-5), Faith Middle School (6-8), and Dexter Elementary School (PK-5).

cent) were military students. Both Russell and Lee Counties enroll less than five percent of military children.

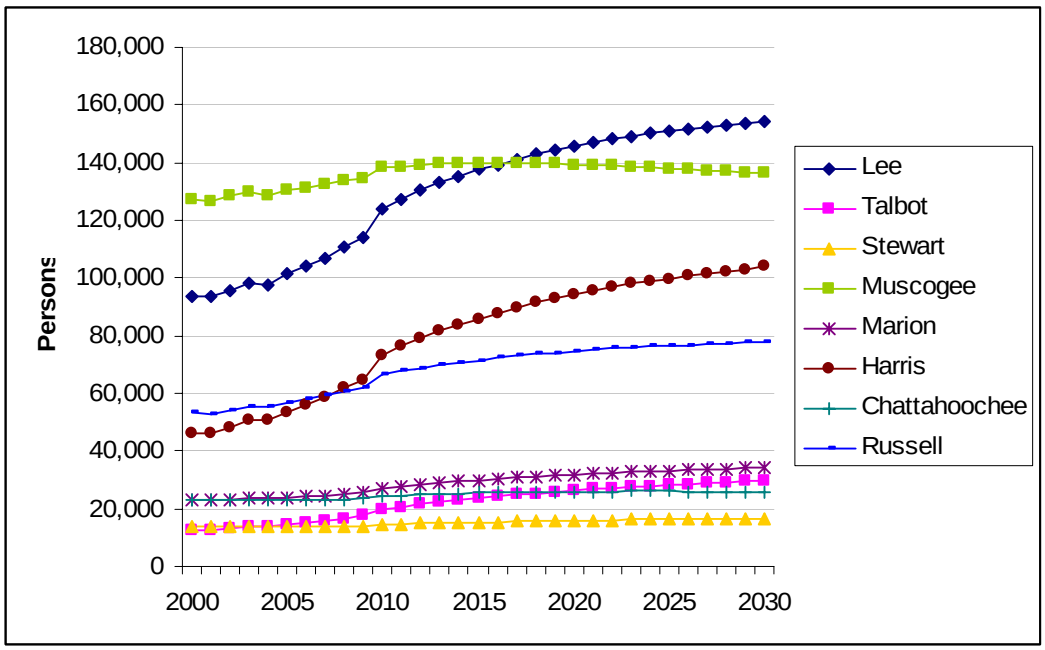
Parents of DDESS students on Fort Benning are aware of inequity of achievement levels between DDESS and LEA schools as older students transfer to LEAs for high school. Addressing concerns of LEA's ability to provide the same level of education and understanding for children of deployed soldiers is critical to the Fort Benning school system. Fort Benning schools have reached capacity, and the potential addition of troops to Fort Benning poses a significant dilemma for family support services. Fort Benning officials are recognizing the situation and in 2005 began conducting a Master Plan Study for the school system.

Measuring the Gap

Population projections for the Fort Benning region* estimate a 78,866 person increase by 2030. Using 2000 U.S. Census counts, 23 percent of Columbus's total population are between the ages of 5 and 18 years. Therefore, it may be estimated that nearly 18,290 additional students will be enrolled within the Fort Benning school systems by 2030. These estimates assume a 19.3 percent increase in population between 2000 and 2030, and do not take Army transformation into account. While in fact, Army transformation will have significant impacts on Fort Benning schools. The proposed addition of troops translates into an additional 3,662 military personnel, 6,665 military family members, 700 civilian employees, and 1,300 contractors. This results in an estimated 9,430 additional students. Figure L3 illustrates population projections by county for the Fort Benning region. A total of 27,720 students are expected in the region by 2030 taking into account BRAC 2005 recommendations and projected population growth (LEAM™ 2005).

DoDEA master plans recommend that DDESS schools on Fort Benning transfer to Chattahoochee County School District. Again, the DoD would remain responsible for building maintenance and operations and improvements to schools located on-post. Additionally, the DoD recognizes that they may need to retain the responsibility of pre-kindergarten within the DoD given the fact that Georgia has a lottery system for pre-kindergarten programs.

* The Fort Benning region includes Chattooga, Harris, Marion, Muscogee, Stewart, and Talbot counties in GA and Lee and Russell counties in AL. The population increase of 78,866 is based on a 19.3 percent population growth rate.



Source: LEAM™ 2005.

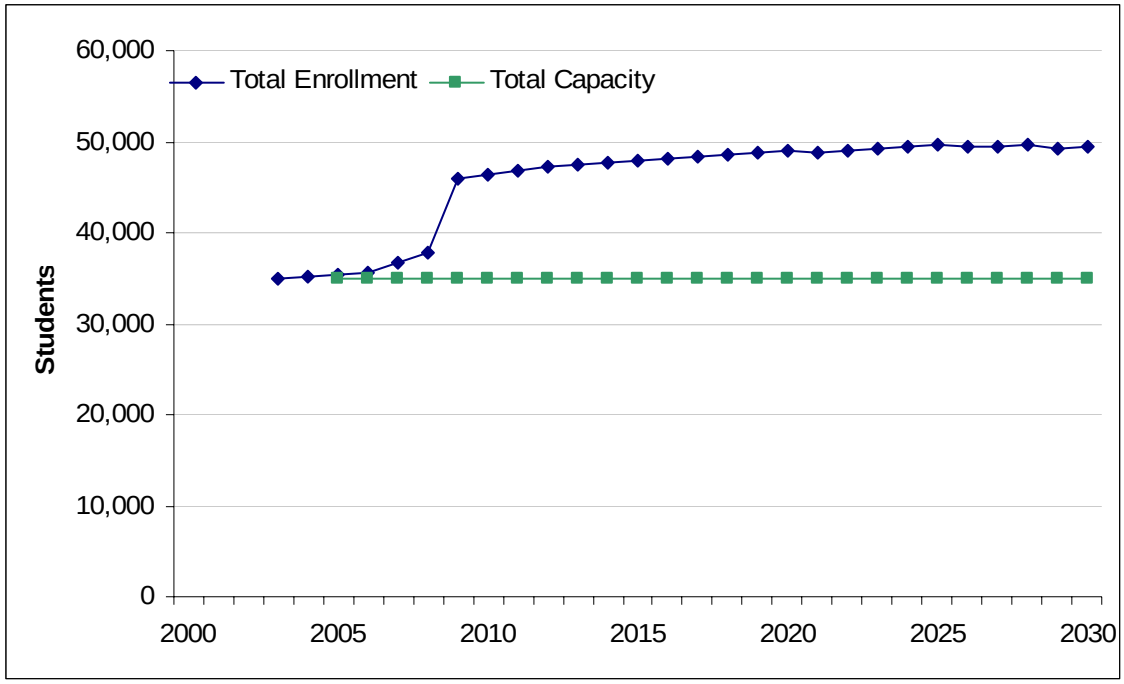
Figure L3. Population increase by county for the Fort Benning sub-region.

Installation officials and parents express concerns about the quality of Chattahoochee County schools and their ability to serve the students. However, the transferred DDESS students would represent the vast majority of student enrollment within the LEA (about 2,400 of the LEA's total post-transfer enrollment of 2,800 would be Federally-connected students). In essence, the Chattahoochee County schools would immediately take on the social, demographic and, to a large extent, the performance profile of the DDESS schools. Further, it is expected that DDESS students would continue to be educated on the installation and, given the immediate need for additional teachers in the Chattahoochee County schools that the recommended transfer would create, it is expected that many of the DDESS teachers would be given an opportunity to continue to teach DDESS students (although staffing decisions would be made at the discretion of the LEA and compensation levels and work rules of the LEA would apply). The pupil-teacher ratios and the per-pupil expenditures of the DDESS and Chattahoochee County are already comparable. Additionally, the LEA superintendent expressed interest in receiving Fort Benning students.

To further complicate Fort Benning's on-post educational sustainability, housing privatization is set to begin in 2008, and this has potential for severe impacts on the educational system.

Both Muscogee and Chattahoochee County School Districts claim to have reached enrollment capacities for those students living off-post. Both school districts are upgrading and adding to existing infrastructure as funds become available. In 2003, Muscogee County School District purchased the community's old Sears building and began a public-private partnership to develop the land. Current site designs suggest public park space, neighborhood housing, a new YMCA complex, upgrades to an adjacent elementary school, and a new administrative building as possible uses. Despite struggles with limited operating budgets, Muscogee County schools are using community partners to foster a quality school system. The district has steadily increased test scores each year and is working with Columbus State University to help recruit and retain the highest quality staff. With help from stakeholders, the district hopes to keep pace with rapidly developing technologies in the classroom.

Figure L4 illustrates estimated enrollments for the Fort Benning region LEAs and DDESS.



Source: LEAM™ 2005; Cumberland County School District, 2005; DoDEA, 2005

Figure L4. Predicted school enrollments, Fort Benning, Accounting for 2005 BRAC recommendations ("Total" = Fort Benning DDESS + Muscogee County School District).

Additional resources will clearly be needed to educate Fort Benning's growing student population. Fort Benning's Education Master Plan will hopefully answer questions concerning where the necessary resources will

come from and who is to receive these resources. It is critical that Fort Benning work with local school districts to ease transformation in both mission and housing privatization to minimize impacts. Fort Benning is on the verge of great changes and needs to provide support to children with the goal of maintaining family services in support of military readiness.

Higher Education Concerns

It is important to note, that although children's education is the highest concern for soldiers, higher education for spouses is also an issue. Both Fort Bragg's and Fort Benning's local communities have strong universities and community colleges. There are over 10,000 students of higher education in both communities. Fayetteville, NC supports Fayetteville Technical Community College (8,310 enrollment), Fayetteville State University (4,490 enrollment), and Methodist College (2,135 enrollment). Columbus supports Columbus State University (5,190 enrollment), Columbus, GA Technical College (1,755 enrollment), Beacon College, and Meadows Junior College. Phenix City, AL maintains Chattahoochee Valley Community College and Troy State University. Preserving strong ties to these organizations should be an additional concern of both installations' long-term goals. Not only does the local support provide well-being for military families, but also a strong pool of qualified employees for military operations.

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14. ABSTRACT

Strategic Sustainability Assessment (SSA) is a long-term project sponsored by the Army Environmental Policy Institute (AEPI), which seeks to provide a fact-based visualization of trends and issues that allows the Army to project the future in terms of the issues critical to sustainability. SSA will produce a variety of models and research tools that will provide strategic analyses in the form of ongoing, regular studies and reports that focus on specific regions or issues, and that help develop implementation plans and concepts for the Army Strategy for the Environment. This initial stage of research defined and conducted specific analyses of key forces, outcomes, and trends related to the SSA as it applies to Army installations using the 20- to 30-year time horizon. This work used a combination of forecasting and backcasting methods to investigate how installations in the selected focus region can overcome specific encroachment concerns and begin to develop sustainable management plans.

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